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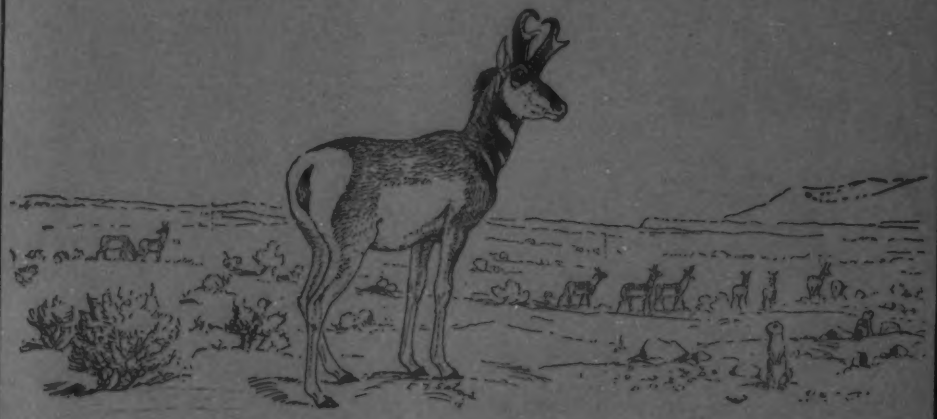

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NOTES ON THE LIFE HISTORY OF THE GRAY SHREW[1]

BY JOSEPH DIXON

[Plate 1]

The purpose of the present paper is to record some recently ascertained facts in regard to the life history of *Notiosorex crawfordi crawfordi* Baird. Through the kindness of an interested friend, the author was able to secure a living individual of this shrew, and to keep it alive in captivity for several months. This shrew fed freely upon live meal worms, and seemed to be carrying on its existence in a nearly normal manner. Opportunity was thus afforded to observe and to photograph this diminutive animal which has until now been thought of as one of the rarest and least known mammals in North America.

This mammal is by no means typical of, or restricted to, the "desert." In fact, the majority of the specimens known from California have been taken on the Pacific slope. For this reason the writer believes that gray shrew is preferable as a vernacular name to desert shrew.

The most striking external features of this insectivore are: (1) small size, adults having an average length of 85 millimeters; (2) very broad ears, protruding conspicuously above the fur; (3) hind foot short (10.4 mm.); (4) tail short, averaging but 40 per cent of the length of the body; (5) color of upper parts neutral gray washed with buffy brown, underparts decidedly paler.

[1] Contribution from the University of California Museum of Vertebrate Zoology.

Measurements in millimeters of five adult Notiosorex crawfordi crawfordi from California

MUS. VERT. ZOOL. NUMBER	SEX	DATE	LOCALITY	LENGTH	TAIL	HIND FOOT	EAR FROM CROWN	WEIGHT
								grams
29244	♀	Jan. 8, 1919	Bernardo, San Diego Co.	88	25	10	3	3.3
1928	♀	May 31, 1908	Dos Palmos Spring, Riverside Co.	82	28	10		
2660	♂	July 23, 1908	Reche Canyon, Riverside Co.	83	29	11		
7474	♂	May 26, 1909	Vallecito, San Diego Co.	92	28	11		
33388	♂	Jan. 14, 1923	9 mi. s. of Escondido, San Diego Co.	83	22	10	3	3.0
Average				85.6	25.6	10.4	3	3.1

The voice of the gray shrew is high-pitched and squeaky, decidedly bat-like in character. When robbed of a morsel of food it had just seized, the animal under observation sometimes gave several decisive squeaks in rapid succession, which could easily be heard at a distance of a yard.

The long, sensitive vibrissæ evidently play an important part in assisting a shrew to sense danger. If a finger or a stick was waved or moved rapidly within six or eight inches of the animal in question, the motion was at once detected. However, if the same experiment was tried with a piece of clear glass between the shrew and the stick the shrew would in no wise be disturbed even if the stick was within one inch of the shrew. The eyes of the shrew are plainly visible (see pl. 1, fig. 1), but the sense of sight is poor, although it was found to be improved in dim light.

The captive shrew spent most of the day sleeping in a dark box, but was found to forage about very actively at night. The sense of hearing was found to be keen, since a slight clicking or other sound always startled the animal even when the source of the sound was several feet distant and outside of the glass cage in which the animal was kept. The shrew depended chiefly upon the sense of smell in locating food, frequently locating and digging out worms that had buried themselves entirely beneath the surface of the sand. Furthermore, when any

strange object was placed near it, the animal immediately began to approach and to smell the foreign article.

The gray shrew gives the impression of being courageous. The one kept in captivity always faced, instead of fleeing from, the antagonist, no matter how large the latter might be. If a person poked the shrew with a finger it at once retaliated by biting sharply. While not serious, the bite could be distinctly felt and was much more effective than one would expect from such a small mammal. If *Notiosorex* were as large as *Ursus* it would be a dangerous antagonist indeed!

The most peculiar thing about the animal observed, when in action, was the twitching of the long sensitive nose and emanating vibrissæ. Another striking feature was the tail, which was carried like a piece of wire, curved up with the tip well off the ground (see pl. 1, fig. 2). When scurrying about over rocks and clods the hind feet were stuck out at right angles to the body. The shrew was thus able to cling to objects successfully, and even descend vertical surfaces head first, by holding backwards with the hind feet. These are well shod with sharp claws. The movements of the shrew were all rapid. Seventy respirations were counted in thirty seconds when the animal was quite at rest.

In seeking to escape notice the shrew did not ordinarily try to crawl into a crack in the rocks but rather sought some slight depression in the open where it huddled motionless. Under such circumstances the neutral gray color of the shrew blended so well with the tone of the sand that it was easy for the animal to escape notice by remaining motionless.

The distribution of *Notiosorex crawfordi crawfordi* is given by Merriam (North American Fauna no. 10, 1895, p. 32), as "Parts of Lower Sonoran zone from eastern Texas to southern California, and thence southward to the cape region of the peninsula of Lower California." In California, specimens have been taken at the following localities. Riverside County: near San Bernardino, 2; Reche Canyon, near Colton, 1; Dos Palmos Spring, 3500 feet, Santa Rosa Mountains, 1. Imperial County: Palo Verde, 1. San Diego County: Vallecito, 1; Santa Ysabel, 2750 feet, 1; Bernardo, 1; 9 miles south of Escondido, 1; 4 miles south of Escondido, 1; San Diego, 1.

Notiosorex is not restricted to any particular association or type of ground. It has been taken amid tules in the Colorado River bottom at Palo Verde; in beehives and under a pile of cornstalks at Escondido; and among yucca and cactus some distance from Dos Palmos Spring in the Santa Rosa Mountains.

To judge from the fewness of captures, gray shrews are rare animals. Charles Schnack of Escondido, San Diego County, has probably seen more live *Notiosorex* than anyone else in California. He states regarding it in a recent letter: "During a period of twenty years I have found five myself and saw the cat with one. I have looked at least 200 times for every one that I have found. Three of the five were found in bee-less beehives in which there was in every instance old bee comb containing more or less wax-moth larvæ." The fourth individual was found in a Dodge delivery car after a lot of old gabled beehive tops had been hauled from an apiary. The fifth specimen was found under a pile of cut cornstalks that were lying on the ground on a hillside. The turning over of 100 adjoining piles of cornstalks failed to reveal any more of the shrews.

It thus appears that the most likely place to look for *Notiosorex* is in or near old beehives. As far as known, these little shrews do not frequent hives in which the bees are strong and active. It is also doubtful if they normally feed on the larvæ of the honey bee to any considerable extent, although the shrew kept in captivity did eat honey bee larvæ when other food was withheld. These shrews are so small that one can curl up in a large walnut shell, and they are able to enter and leave the beehives through the regular entrances made for the bees. One shrew was observed by the writer to crawl repeatedly through an opening a quarter of an inch wide. It is probable that *Notiosorex* frequents old beehives for both food and shelter.

Tracks made by this small mammal are so faint as to be rarely if ever seen under ordinary conditions. The droppings are regularly deposited in certain chosen places such as the vantage point on the top of a small rock. The feces are bat-like in character and are deposited in strings, wienerwurst fashion. Each pellet is about one millimeter in diameter and from six to eight millimeters in length.

There is little tendency shown by the species toward burrowing. The individual kept in captivity was noted on several occasions to dig vigorously in soft sand with the fore feet. Such digging activities were clearly associated with the search for food rather than with the construction of a burrow.

Mr. Schnack reports finding two nests or sleeping quarters. The first was a sort of platform, found in an old beehive, and was two inches across, with a small depression in the center. It was made of the spider-web-like material commonly left by the bee moth. The second nest was found in a corn field under a pile of corn stalks. This nest

measured 1¼ by 1½ inches in diameter and was made of fine grass, corn silk, and a few bird feathers. In both instances the nest was inhabited by a single individual, in one case a male, in the other a female. Outside of the breeding season, members of either sex appear to lead more or less solitary lives.

Very little is known about the breeding habits of *Notiosorex*. Frank Stephens, in California Mammals, p. 255, states: "A female caught in San Diego April 8, 1906, contained three half-grown fœtuses. There were three pairs of mammæ all located near the groins." A female, number 1928 in the Museum of Vertebrate Zoology, taken May 31, 1908, had large mammæ and was apparently nursing young.

The shrew kept in captivity was especially fond of meal worms, taking them in preference to any other food offered. Four to seven large meal worms, each weighing one-third of a gram, constituted a day's ration. On one occasion three large meal worms were eaten within a period of ten minutes. After this meal the shrew retired to its nest of cotton and was left for a while undisturbed. Four hours later the animal ate four more large meal worms which constituted the last meal for that day. The shrew thus consumed 2⅓ grams of food, or about 75 per cent of its own weight, each day.

The captive shrew was twice left without food for 36 hours, and at another time had nothing to eat for 48 hours, without any apparent ill effects. It has been stated frequently that such insectivorous mammals as shrews and moles must have food at frequent intervals or else they die. This certainly is not true in the case of *Notiosorex*.

Following an enforced fasting period, a number of meal worms were placed in the cage. The shrew immediately began running about in a frenzy of activity, securing seven of the meal worms in five minutes. The shrew bit each worm through the head so as to stun it. The crippled worm was then carried to the shelter of a rock and deposited with its fellows to form a heap. After seven worms had thus been rendered helpless, they being unable to escape by burrowing into the sand, the shrew began its meal which did not end until all seven worms had been devoured. When a meal worm was placed on the sand within two inches of the shrew's nose the animal detected the worm at once and after a moment's hesitation pounced upon it and devoured it head first. The front feet were sometimes used by the shrew to grasp the worm while it was being bitten through the head; but after this initial stage the fore feet were not used in feeding operations (see pl. 1, fig. 3).

On one occasion some uninjured meal worms sought to escape by crawling under a small dish. The shrew soon scented them and made obvious efforts to get at them. Failing to reach them from the rear the animal drove them out to the other side of the dish and then rushed around and grabbed them before they could get back under cover.

In order to test out food preferences a small live slender salamander (*Batrachoseps attenuatus*) and two live earthworms were placed in a cage with the shrew. The odor of the salamander was evidently very repugnant to the shrew, because after taking one sniff of it the shrew retired, shaking its head and twitching its nose. The earthworms were likewise not molested.

Contrary to expectation, the so-called "desert" shrew drank water almost daily, lapping the water like a cat. The long nose was not immersed. On one occasion the shrew drank eleven times in five minutes, lapping the water with the dainty tongue from five to twenty times at each drink.

Specimens at hand indicate that there is but one molt each year in *Notiosorex*. This molt apparently occurs during May and June. An adult female, number 1928, taken May 31, 1908, has broad patches of short new neutral gray hairs on the head and rump. The hind legs, back and sides are still covered with old long faded hair. An adult male, number 7474, taken May 26, 1909, has the new short gray hairs coming in on the head, while the back, rump and hind legs are still covered with the old long buffy coat. A male, number 2660, taken July 23, 1908, has completed the molt and the hair is shorter, fresher, and grayer or more plumbeous in tone than in the other specimens. A male, number 33388, taken January 14, 1923, has the long full winter coat in which the neutral gray hairs of the back are washed or tipped with buffy brown.

Berkeley, California.

FIG. 1. GRAY SHREW IN LIFE, NATURAL SIZE

Note the broad, prominent ear

FIG. 2

When the shrew was travelling, the tail was carried curved up like a piece of stiff wire.

FIG. 3

The fore feet were not used in the feeding operations after the meal worm was dead.

NOTIOSOREX CRAWFORDI BAIRD

MAMMALS FROM THE MACMILLAN EXPEDITION TO BAFFIN LAND

By Glover M. Allen and Manton Copeland

The smaller mammals brought back from Baffin Land by the MacMillan Expedition, were taken in the spring and early summer of 1922 in the vicinity of Cape Dorset and Bowdoin Harbor along the extreme southwestern coast. They consist chiefly of skulls and a number of flat skins, for the most part without exact data. They are of some interest, however, as coming from a part of the Arctic Archipelago that is but little known.

Our thanks are due the Museum of Comparative Zoölogy and the United States Biological Survey for the opportunity of making direct comparison with specimens from other localities.

The following six species are represented.

Alopex lagopus innuitus (Merriam)

ARCTIC FOX

A series of over forty skulls was brought back, collected at Cape Dorset, Bowdoin Harbor, and elsewhere. Those of the same sex show more or less variation in size, length of nasals, and degree of flatness of the forehead. They resemble the Point Barrow and northern Alaskan specimens in their slightly shorter nasals and blunter thickened postorbital processes as compared with the Labrador form, *ungava*. As a rule, however, the lower anterior premolars are not in contact, but very slightly spaced as in the latter. All the characters used in separating the different races are variable and of slight average value only. Merriam refers to this race a single specimen in the United States National Museum, from Cumberland Island, in eastern Baffin Land, remarking that the lower premolars are somewhat larger than those of Alaskan skulls. In the MacMillan series, however, there is apparently very little actual difference in the size of teeth as compared with specimens from northern Alaska, but the lower premolars are very slightly spaced instead of being in close contact.

The weight of an adult male from Bowdoin Harbor is recorded on the label as six pounds; four others weighed from five to nine pounds, and the average for the five is a little over seven.

Mustela arctica arctica (Merriam)

ARCTIC WEASEL

Two skins in summer pelage are unquestionably this species. One is a male from Cape Dorset, taken August 7, 1922. It is pale brown above, and white below with a pale yellow suffusion which extends to the entire fore feet (except the wrists, which are brown), as well as to the toes and inner sides of the hind feet. The end of the tail is black. The second specimen is smaller, and so probably a female. It is similarly colored, but whiter on the lips, and has the under side of the tail whitish with a pale yellow wash, and a white spot at the posterior corner of each eye.

Phoca hispida Schreber

RINGED SEAL

There are three skulls of this high-northern species from Bowdoin Harbor, collected in early June. It may have been this seal that Peary saw as far north as there was open water. The northern and western limits of the different species of seals on the eastern and northern coasts of Baffin Land are still in need of more exact determination.

Lemmus trimucronatus (Richardson)

BACK'S LEMMING

The most interesting of the small mammals is this lemming, previously not known to occur farther northeastward than the Melville Peninsula and the shores of Boothia Felix. Its presence in southwestern Baffin Land perhaps indicates that individuals have at some period crossed from the mainland since the last advance of the ice at the close of glacial times.

Although it does not become white in winter like its near relative *Dicrostonyx*, there is nevertheless a very obvious difference between summer and winter coat. That of summer, in addition to being shorter and less silky, has a well-marked chestnut patch on the rump, standing out in contrast with the bright fulvous of the flanks; whereas the winter pelage is a nearly uniform ochraceous posterior to the shoulders, quite without the chestnut patch. This difference does not seem to have been generally noticed and a failure to recognize the two pelages is perhaps partly responsible for the account of supposed color differences of the race *yukonensis*. Of this latter we have examined skins taken at

no great distance from the type locality and do not find any characters that will separate them from comparable specimens of the brightly colored *alascensis* of Point Barrow, which is distinguishable from typical *trimucronatus* by its brilliant ochraceous-rufous sides and belly, in contrast to the pale ochraceous wash seen in the latter. The original description of the race *alascensis* seems to have been based on the winter pelage, whereas that of *yukonensis* was founded on a summer specimen. The skulls of the two, however, are quite different in the shape of the basioccipital, which in *alascensis* and typical *trimucronatus* is broadly V-shaped, whereas in *yukonensis* it is so encroached upon by the bullæ as to be very narrow and almost parallel-sided.

The MacMillan Expedition obtained Back's lemming in winter pelage at Bowdoin Harbor, March 6 and 7, and others in summer coat, June 16, at 65° north latitude on the west coast of Baffin Land. One very small young without date is also in the collection. In color it is much duller than adults, a nearly uniform yellowish gray above, more clearly buffy at the sides, and whitish below with a faint buffy wash on the throat and chest. Externally the adults agree in every particular with specimens from northern Mackenzie, kindly loaned us by the United States Biological Survey and taken to represent typical *trimucronatus*.

The occurrence of this species in southeastern Victoria Land, north of Coronation Gulf, is worth recording here. Three specimens collected at De Haven Point and Taylor Island a few years since, were presented to the Museum of Comparative Zoölogy by Col. John E. Thayer. So far as we can ascertain its presence has not been known previously on any of the islands of the Arctic Archipelago.

Dicrostonyx grœnlandicus (Traill)

GREENLAND LEMMING

A number of skins, representing old and young in summer and in winter coat, seem referable to this species rather than to any of the continental forms. The one or two skulls preserved are similar to those of the Greenland lemming in tooth characters.

Adults in early July are in almost full summer pelage and a single one from Cape Dorset, August 15, is not essentially different. They are an almost uniform mixed gray and black above, but quite without a distinct median black line. At the sides of the body and underneath

they are white with a wash of pale ochraceous and there is an ill-defined chestnut patch in the ear region. Five skins taken July 1 and 5, at Bowdoin Harbor, agree closely in this coloration. A young one, about a quarter grown, is a buffy gray above with the ear spots a slightly brighter rusty. On the nape there is a short and indistinct median blackish line which, however, is so mixed with buffy hairs as hardly to be noticeable. This reduction of the median black stripe in both young and adult is characteristic of *grœnlandicus*, for in all the other American forms it is strongly marked.

A number of flat skins, still in full white winter pelage, were taken as follows: Cape Dorset, March 10; latitude 65°, February 7; fifty miles north of Bowdoin Harbor, April 1; [Bowdoin Harbor], May 1. A half-grown young, Bowdoin Harbor, March 18, has the enlarged winter claws, while its white coat already has a considerable admixture of dark hairs coming in, particularly on the nape. An older and nearly full-grown specimen, taken April 22 at the same place, is similar, with the entire dorsal area a buffy gray, due to the incoming long hairs of the summer coat. Older specimens (Bowdoin Harbor, May 5; Cape Dorset, May 22) retain areas of long white fur on the back and lower flanks, but elsewhere are much darkened by the new pelage. A second specimen from Cape Dorset, May 22, probably a younger animal than the other, is in nearly complete summer pelage; while an adult male from Bowdoin Harbor, June 28, retains nothing of its winter coat but a small tuft of white on the lower rump. The enlarged claws of winter are still unshed at this date, though their upper portions have worn so as to expose the long blackish nails of the summer condition. The variation in time and rate of moulting the white winter coat is doubtless largely dependent on the age and general condition of the individual (see Bull. Mus. Comp. Zoöl., vol. 62, p. 527, 1919). Judging from the size of the skins also, there must be either more than one litter of young in a year or much variation in the time of their birth. Unfortunately the two youngest specimens in the collection are without dates, but though of about the same size and perhaps from a quarter to a third grown, one is in a whitish pelage with enlarged claws (probably taken in late winter), and the other is in grayish summer coat with normal claws (probably born in early summer). Additional observations on the times when young are born and when they acquire winter or adult summer pelage are much desired.

Captain MacMillan writes us that these lemmings were "very numerous everywhere, winter and summer." He had many as pets

and they were easily tamed. They fed largely on the bark of the dwarf willow. In the winter they tunneled long passages under the snow, and these led up through to the surface with a clean round hole about $1\frac{1}{4}$ inches in diameter. When surprised and cut off from retreat, they would stand up on their hind legs, strike their fore paws together, chatter with their teeth and squeak. The arctic fox and the snowy owl seemed to be their chief enemies, as well as the wolf, ermine and rough-legged hawk.

It may be added here that a few summer specimens from Victoria Land, west of the McClintock Channel, lately presented to the Museum of Comparative Zoölogy by Col. John E. Thayer, are, rather unexpectedly, quite similar, and are referred without doubt to *grænlandicus* which seems to be the species of the Arctic Archipelago rather than *rubricatus* or its races of the American mainland.

Lepus arcticus Ross

AMERICAN ARCTIC HARE

Twelve skulls from Bowdoin Harbor and adjacent region may be considered typical of this species which was described by Ross from specimens obtained in northern Baffin Land, southeast of Cape Bowen.

When writing his revision of the North American rabbits, Nelson (North Amer. Fauna, no. 29, p. 63, 1909) had but a single "young adult" skull with head-skin, and a young skin from Baffin Land, and was unable to find any characters by which to separate *labradorius* (type locality Fort Chimo, Labrador) from *arcticus*. He therefore considered the two synonymous. But a comparison of the MacMillan series with a fine series of skulls in the Museum of Comparative Zoölogy from northeastern Labrador (Pamialuk, Makkovik, Rama, Hopedale), clearly shows that *labradorius* is entitled to recognition as a valid race. While the total length of skull is the same in both, that of *labradorius* is obviously broader, with usually longer though equally broad nasals, longer incisive foramina, slightly greater diastema, greater breadth across zygomata and cheek teeth, while the lower jaws, as a result of the greater palatal width, have their rami obviously more widely divergent. The last character and the larger nasals are most striking to the eye. Though the linear length of the nasals may be from only 2 to 5 mm. greater, this implies an increase in their surface extent of from 34 to 85 square mm., an additional area that is at once apparent to the eye.

Measurements of Arctic Hare Skulls

	ARCTICUS					LABRADORIUS				
Condylobasal length	86	88	84	88	89	88	90	80	87	88
Nasals, tip to posterior corner	38	40	40	39	42	42.5	43	42	42	42
Nasals, combined width posteriorly	21	18.5	22	21	21	21.5	22	22	22	20
Incisive foramina, greatest length	22	22.5	21	20	22	23.6	25	24	23	23
Incisive foramina, greatest width	10	10	9	10	10	10	10	11	10.5	10
Greatest zygomatic width	48	48	46	48	48	49.5	51	49	49	49
Width outside cheek teeth	26	26.5	26	27	26	28	28.5	28	27	29
Mastoid width	28	28.5	28	28	28	30	30	29	29	29
Across angles of lower jaws		39	41	41	36	44	46.5	47	42	44

Occasional adults of *arcticus* occur, however, in which the nasals are as long as in the Labrador animal. The average characters are, nevertheless, perfectly evident, so that the latter may be reinstated as a tenable race, *Lepus arcticus labradorius* Miller.

Cambridge, Mass.

ALPINE LIFE OF THE HEATHER VOLE (PHENACOMYS OLYMPICUS)

By William T. Shaw

[*Plates 2–4*]

In appearance *Phenacomys olympicus* is very much like the common meadow mouse (*Microtus*), but in keeping with the sunlight and much snow of its habitat, is noticeably lighter in color and is further distinguished by having a much shorter tail. In summer it lives among the heather (*Cassiope* and *Phyllodoce*) well up among the snow patches, even to the foot of the glaciers. It may be found among the comparatively dry hill slopes at a lower elevation as well, and rather characteristically occurs in such log-tangled areas as former fire zones. During winter it ranges somewhat lower and inhabits open park country, even associating with the large Richardson vole (*Microtus richardsoni arvicoloides*) in territory occupied. Its habits, however, are quite different from those of the Richardson vole and the winter work of each is very clear-cut and distinct even when side by side in the same territory.

Winter nest.—While the Richardson vole is a very rough, untidy animal and leaves his neighborhood much riddled with holes and under snow foraging paths, strewn and packed with discard from his foraging, the heather vole, always neat and trim, leaves scarcely a trace of his hibernal occupation save for the very conspicuous and unique subsnow nest. This is, indeed, very characteristically neat and *Phenacomys*-like. These nests are lined with soft shredded blades of snowgrass (*Juncoides*) and made snow-resistant by well-selected pieces of branching lichen gathered from among the stones of an old moraine. One nest was found constructed of beargrass (*Xerophyllum*). At Twin Lakes, Mount Winchester, near Shuksan, a very neat winter nest was found in the sheltering angle of two projecting rocks. It was about the size of that of a robin, completely arched over and faced into the little cave formed by the rock angle, and was formed of a frame work of white heather twigs, the interstices being filled with leaves of huckleberry which grew here in equal abundance with the rose and white heathers. It was lined with finely shredded grass. Four others were found close against the south side of rocks. They were made of the material at hand, some at a lower elevation being made of grass blades.

Summer nest.—The summer nest is underground. Scarcely an indication of its presence exists. A small round hole (A, Fig. 2, 3, 5), so heather-grown and covered as to be almost, and sometimes quite, invisible, leads below to a snug nest of dead grass and moss fibers, and here young *Phenacomys* are nestled in luxuriant warmth and dryness (Figs. 2, 5). Others of these small *Phenacomys* doors lead deep into the rocky recesses of moss-grown moraines, by passages forbidden to most of their enemies.

Food.—If one looks very closely near the winter nest, one will find bits of the denuded twigs of white heather, indicative of the winter food. Beargrass was once found which had been used for food. The red heather seems not to be taken. The summer provender is selected with great care as to succulency and one may find clusters of the stems of lousewort (*Pedicularis*) and freshly cut huckleberry leaves at the entrance of the burrows.

Breeding habits.—One late August day, in Spray Park, Mount Rainier, high up on a land of old brown and gray boulder-strewn moraines, heather-carpeted, among the last struggling trees, (Fig. 3) I found a subsnow nest of *Phenacomys*. It lay out in the open heath, among stunted heather on the surface of the ground. Other nests were scattered here and there in similar situations; one was in a niche in the side of a

heather bank, one appeared under a sheltering rock, all were above ground. They were deserted, yet neat and intact, as when revealed by the melting snow (Fig. 4).

In this promising area I went trapping and caught a large male heather vole in a runway through red and white heather. This little trail showed very slight signs of use, and one could only hope and guess as to its being an active highway. It led from a thicket of alpine fir (*Abies lasiocarpa*) and mountain hemlock (*Tsuga mertensiana*), such as crown the wind-swept knolls of snow line, out into the feeding grounds of open park where were the heathers (*Cassiope* and *Phyllodoce*) and a little snowgrass (*Juncoides*), wild parsnip (*Ligusticum purpureum*), and an alpine lupine (*Lupinus lyallii*). All of this ridge was on the lower edge of a glacial lakelet with its farther shore in perpetual snow.

Anxious to know more of the rare nocturnal mouse, and, like many another trapper, lured with success, I sought further fields to enter. Near one of the subsnow nests a small hole was found, rather fresh-looking, so a trap was placed by it. In the morning the trap held a deermouse (*Peromyscus*). A hundred yards or so away another hole was detected, with seed stocks of lousewort (*Pedicularis*) and a few very fresh green *Vaccinium* leaves about and in it. A trap was placed here also. On August 27 there were specimens of *Phenacomys* in the traps at each of these holes. The second mentioned hole looked to be of more than usual interest, so it was investigated and the den excavated (Figs. 2, 5). Within a very few inches of the entrance a nest of true moss, lined with finely shredded grass, was found, and in it four very young *Phenacomys*. They were much like young ground squirrels when born.

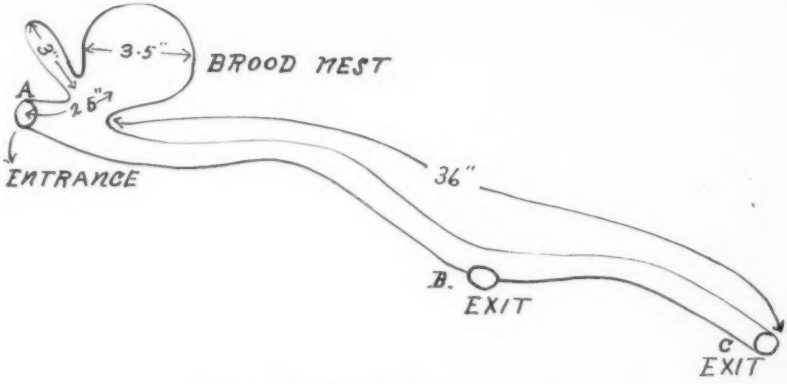
The Brood Den.—The burrows ran only an inch or so below the surface, simply beneath the roots of the heather. A remarkable thing was that the burrows did not have any signs of fresh work about them. The old holes seemed to be perfectly open except when they were not used. A hole at B, figure 5 appeared to come up from below and was quite moss-clogged and hard to detect. The hole at C was found to open in the side of a little bank or foot print in the soil. The nest itself and the hole at A were in the side of a small bank about a foot high (Fig. 3). The seed stocks of the lousewort plants growing near this nest had been harvested and carried to the entrance of the brood nest.

PHENACOMYS OLYMPICUS

(Shaw: Alpine Life of the Heather Vole)

HABITAT OF PHENACOMYS OLYMPICUS

(Shaw: Alpine Life of the Heather Vole)



DEN AND NEST OF PHENACOMYS OLYMPICUS

(Shaw: Alpine Life of the Heather Vole)

EXPLANATION OF PLATES

PLATE 2

Heather vole (*Phenacomys olympicus*)

FIG. 1 (upper). Posture study in natural habitat. ½ natural size. Owyhigh Lakes, Mount Rainier; 5150 feet. August 8, 1919.

FIG. 2 (lower). Brood nest and young, *in situ*. The nest is located beneath the root-bound turf of an old moraine. Spray Park, Mount Rainier; 6000 feet. August 28, 1919. Photos by Wm. T. Shaw.

PLATE 3

Heather vole (*Phenacomys olympicus*)

FIG. 3. Habitat landscape. The wind-twisted trees are the subalpine fir (*Abies lasiocarpa*) and the mountain hemlock (*Tsuga mertensiana*). Much of the foreground is covered with white heather (*Cassiope*). The brood nest shown in figure 2 was located at A in the foreground. Spray Park, Mt. Rainier; 6000 feet. August 29, 1919. Photo by Wm. T. Shaw.

PLATE 4

Heather vole (*Phenacomys olympicus*)

FIG. 4 (upper). Subsnow nest, *in situ*. Made of shredded grass blades and lichens. It is resting on the surface of the ground in the moraine landscape shown in figure 3. For winter use only.

FIG. 5 (lower). Plan of den and nest.

Pullman, Washington.

PREPARATION AND PRESERVATION OF ANATOMICAL AND EMBRYOLOGICAL MATERIAL IN THE FIELD

By Adolph H. Schultz

Museums the world over contain large numbers of skins and skulls of mammals, and our knowledge of these parts is consequently well advanced. The study of the soft parts of the mammalian body, however, is much less complete. This is largely due to the fact that comparatively little interest has been manifested in the past in the systematic collecting of entire animals and that the conditions of preparation and preservation of the soft parts are not sufficiently well known to most collectors, being in general regarded as too complicated and troublesome to be practicable in the field. Thus, on most expeditions, only occasional smaller animals are preserved intact, and for anatomical studies on larger mammals one has to rely on such specimens as die in zoological gardens, which unfortunately are often pathological. Naturally, there are limitations to what can be preserved in the field, as it is impossible to transport the entire bodies of the largest mammals. However, almost every single part of a body would be of great value and might help to fill one of the many gaps in comparative anatomy. Here it may also be stated that one cannot collect too many duplicates for the study of the soft parts, just as in the case of skins and skulls. The variability in muscles, blood-vessels, and nerves is even more pronounced than that in bones, and it is the rare extreme variation which often throws most light on questions of derivation and relationship. Of unborn animals many different stages are necessary before a complete study of their development can be undertaken; a modest beginning has been made toward this end, since fetuses and embryos are being saved by field collectors with increasing frequency. However, the value of this material could often be augmented by more appropriate preservation.

The first requirement for the successful and lasting preservation of an animal, with the exception of very small specimens, embryos and young fetuses, is embalming. No preserving fluid has been found so far that, when a fairly large animal is merely submerged in it, will penetrate the tissues rapidly enough to reach the innermost structures of the body before decomposition has set in. The frequently practiced method of slitting the abdomen for the purpose of allowing the preserving fluid to enter the body is a crude and far from ideal procedure and renders the specimen useless for certain anatomical investigations. If an animal

is embalmed—that is, if the preserving fluid is injected into an artery, the fluid is evenly and quickly distributed all over the body and will readily diffuse from the blood-vessels into the neighboring tissues. In this way the body does not shrink nearly as much as by the application of the old method, the topography of the intestines is retained in the condition in the living, and the muscles will be found much easier to dissect. Naturally, embalming an animal requires somewhat more time and equipment than the other way of simply cutting open the abdomen and dropping the specimen into alcohol; but the difference in results fully justifies the slight increase in labor and necessary apparatus. The latter consists chiefly of a bottle with a bottom outlet, a rubber tube at least eight feet long, and several cannulæ, either of glass or metal. Drawing A of figure 1 shows the type of bottle which has been found most suitable; it should hold approximately 1000 cubic centimeters. In case it is thought that glass is too easily broken on an expedition, a brass or copper tank could be made of similar size and design. After filling the bottle or tank with the embalming fluid it is hoisted up to the branch of a tree by means of a strong cord. In experimenting with various pressures the writer has concluded that with the bottle six to eight feet above the specimen to be embalmed, a pressure is obtained that is not too high for smaller specimens and yet which will force the fluid easily, even through a large animal, such as lion or tiger.

The cannula at the lower end of the rubber tube, which is to be inserted into an artery, can be made at home from a glass tube over a gas flame. Since it is inserted into the blood-vessels at an angle, it should be bent a trifle in order that its opening may not touch the wall of the vessel. A slight knob at the end of the cannula prevents it from slipping back after it is tied into the artery, as shown in drawing C, figure 1. A number of cannulæ of different sizes, and especially of various widths, should be taken along, since the arteries in small animals naturally can take only very fine cannulæ, while one would use a wide glass tube for the heavy artery of a large mammal—otherwise the embalming would take too long. For use in the field, it may be found that a set of metal cannulæ are preferable; they should be of copper or some other metal that will not rust or corrode easily. Hypodermic needles for very small mammals and spinal puncture needles for larger ones can be used very well for this purpose. The sharp point must be filed off and a little knob soldered to the end.

Drawing B, figure 1, shows the way an artery should be cut to allow the cannula to be inserted. The vessel should be merely clipped with a

pair of fine scissors. If the artery is cut clear through, its ends will pull away from each other and it will become very troublesome to hold them in place. The cannula is inserted and tied into the vessel so that

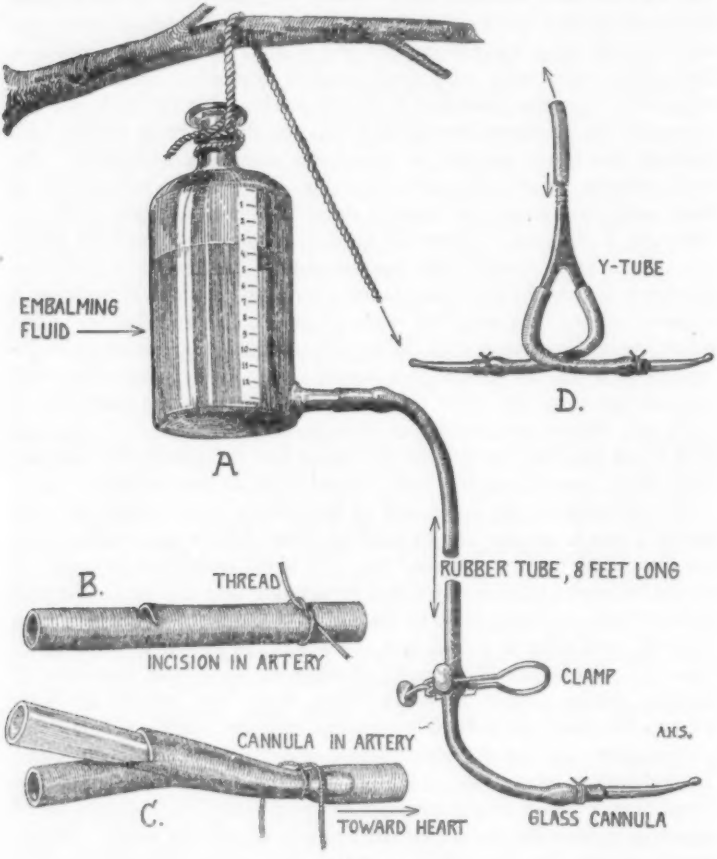


FIG. 1

it points toward the heart. Before this is done the embalming fluid should be let down through the tube to the very tip of the cannula, where it can be held by merely using the clamp on the rubber tube.

In this manner there will be no air bubbles injected with the fluid. Air bubbles are apt to stop the embalming process when they, with the fluid, reach the capillaries.

Opinions differ as to the best and most convenient artery in which to tie the cannula. For general purposes the author is firmly convinced that the femoral artery is to be preferred to any other. Figure 2 shows this artery and its location in some mammals. The first sketch is that of a skinned left hind-leg of a cat, from the medial side; just between the group of extensor muscles on one side and the adductor muscles on the other, and situated close to the surface, are the femoral artery and vein, together with some nerves. Examples of marsupial, insectivore, and primate demonstrate that this artery can be exposed by a comparatively small incision in the skin. This should always be made in the middle of the inner side of the thigh, close to the abdomen. By pulling the skin back on either side of the cut, the large blood-vessels are quickly located. The artery can be distinguished from the vein in the dead animal by its greater elasticity, lighter color, slightly smaller caliber, and especially by the fact that in all mammals the artery near the abdomen lies lateral to the vein. The embalming itself should be kept up at least until the tissues feel well hardened, not only on the abdomen, where they first become firm, but also on the head and limbs. Furthermore, one should wait until the fluid starts to run out of the mouth and nose, indicating that the embalming has reached the lungs, through which the fluid penetrates in part and, together with the air bubbles from the lung cavity, is pressed through the trachea to the mouth. In order to see how much fluid has been injected, it is well to graduate the embalming bottle with ten to twenty units; this serves also to detect quickly whether the fluid is running at all, which in rare instances may not be the case, especially when blood has clotted in the arteries. With the latter trouble one has only to raise the bottle temporarily one or two additional feet, thereby raising the pressure. The marking or graduating of the bottle is done most easily on a piece of adhesive tape stuck to the outside of the bottle. In case of a metal tank the same result is achieved by using a cork-float on the surface of the embalming fluid into which a graduated perpendicular light bar has been placed. This can be read off above the upper edge of the tank over which it projects.

After sufficient embalming of the body, the cannula is pulled out, the artery tied proximal to the incision, and the cannula again inserted through the same incision, but this time pointing in the opposite direc-

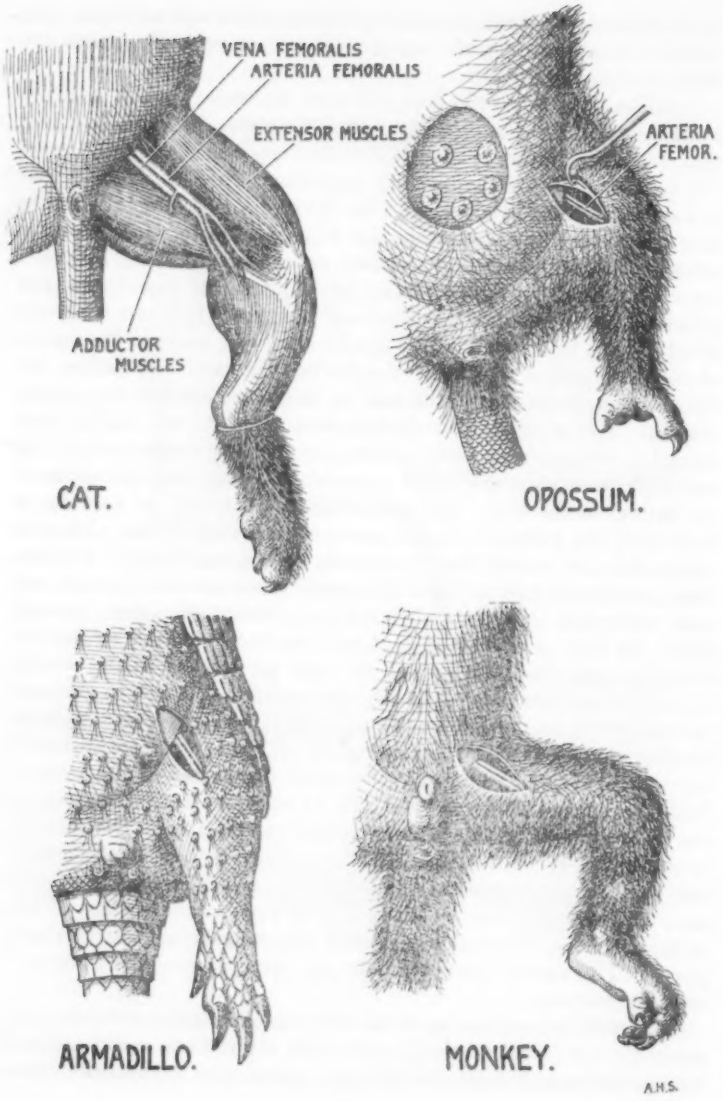

VENA FEMORALIS
ARTERIA FEMORALIS
EXTENSOR MUSCLES
ADDUCTOR MUSCLES
CAT.
ARTERIA FEMOR.
OPOSSUM.
ARMADILLO.
MONKEY.
A.H.S.

FIG. 2

tion, toward the foot. Five minutes of injecting in this way will insure preservation of that hindlimb equal to that which has been given to the other parts of the body. For time-saving, the embalming may be done in both directions simultaneously by using a Y-tube, as shown in drawing D, figure 1. This requires a second incision in the artery somewhat distal to the first.

Should an especially thorough preservation of the brain be desired, particularly in larger mammals, the cannula should be inserted, after the general embalming, into one of the carotid arteries in the neck, pointing toward the head. If the brain alone is to be saved, it is better to embalm the head first, in the above manner, and then remove the brain about two to five hours later, rather than to take the brain out in a fresh condition. In this way the brain will retain its natural shape and one is less apt to injure it when lifting it out of the skull. The preservation will be found to be very satisfactory if the head is well embalmed. Should only the head and neck of a larger mammal be kept, embalming of these parts should be done through one or both carotid arteries, which are easy to find on the cut surface of the neck. In such cases it is well to suspend the head in such a way that the cut surface of the neck is horizontal and uppermost. If an animal has been shot and the bullet has pierced one of the larger vessels, this vessel should be laid open by as small an incision as possible and tied off on the side of the bullet hole which is nearer the heart. Should the aorta have been struck, the cannula should be tied directly into the bullet opening in this large vessel and the embalming done in each direction. In a similar way, should the heart itself have been hit, one should expose the heart by an incision through the cartilaginous portion of the left ribs and insert the cannula directly into the aorta where it leaves the heart.

It is almost impossible to embalm small mammals, such as shrews, bats, field mice, etc., through an artery. In such cases a good preservation is obtained by injecting the embalming fluid with a syringe through the mouth and anus, using as large a needle as will pass for some distance into the œsophagus and into the rectum. In addition, one may inject some fluid into the lungs and the stomach with a syringe, but this time with a fine and sharply pointed hypodermic needle.

In most museums alcohol is used as a preserving fluid almost exclusively. It is true that alcohol does not attack the skeleton as do some of the other preservatives, but it shrinks the tissues very much and does not penetrate them readily. After many years of experience and

experiments with alcohol, carbolic acid, formalin, oils, and other means of preservation, the writer is firmly convinced that formalin is superior to any of the others, except perhaps for some rare special purposes. The best general preservation is invariably obtained by the use of a 10 per cent formalin solution or one of even lesser percentage. Besides many technical advantages, formalin has the distinction of being a good deal cheaper than alcohol; furthermore, one can carry it in the concentrated form of the commercial 40 per cent formaldehyde and dilute it in the field, just before using, with nine parts of water, thus making the required 10 per cent solution. For embalming it is well to add five parts of glycerine to every 100 parts of the 10 per cent solution; this leaves the tissues somewhat softer and keeps them moister when exposed to air during later dissection. Instead of glycerine ordinary salt can be added to the formalin in order to prevent the tissues from hardening too much. The author is indebted to Mr. H. C. Raven for this information. Mr. Raven uses about a six per cent formalin solution in which salt is dissolved to nearly the saturation point. After the animal is both embalmed with it and submerged in it, the tissues remain soft and the muscles flexible which is a great advantage. The author has had no experience himself with this particular method, but from an examination of some of the material treated in the above manner by Mr. Raven he would highly recommend it. A well-embalmed specimen should be immediately afterwards submerged in a 10 per cent formalin solution for at least one day, so that the skin will be thoroughly fixed. After this it will keep for many months in excellent condition if placed in some container, such as a tin can, in which the empty space is filled with sawdust or absorbent cotton that has been saturated with formalin in a 10 per cent or even weaker solution. For final permanent storage the specimen should rest entirely under fluid.

Studies on blood-vessels are greatly facilitated by injecting the vessels with some coloring matter. In the field this, of course, can hardly be done in every case, but whenever possible it certainly would be a valuable help later to the investigator. After embalming with formalin, the femoral artery is again opened within five to twenty-four hours, according to the size of the animal, and the coloring mass injected with the same apparatus as used before for embalming. Probably the best, if not the only coloring mass feasible in the field is ordinary starch to which some color has been added. This will give very good results and is used extensively in anatomical laboratories. The starch is first

mixed with water until it has about the consistency of milk or cream. For coloring this mixture one may use prussian blue or cinnabar for red. Both of these come in powdered form but should be ground in a mortar or first dissolved for a considerable time, so that no large granules are left which might obstruct some of the finer blood-vessels. A more simple and just as good a method consists in adding India ink, especially Higgins' ink, to the starch, and here, of course, almost any desired color can be obtained. In case of small mammals, in which the starch does not always reach the finer vessels of hands and feet, a saturated shellac solution, with which some color has been mixed, may be preferred. This solution should be strained through a double layer of fine-meshed cheesecloth before it is used. In contrast to starch, shellac does not fill the blood-vessels but only coats the inside walls. If one intends to inject some coloring mass into the vessels, one should open the femoral vein before the first embalming with formalin is started, so that as much blood as possible can escape and the vessels be well emptied preparatory for the later coloring mass.

Every female animal killed should be examined for embryos or fetuses and, wherever possible, not only these but also the placenta or afterbirth, uterus and ovaries should be saved. Larger fetuses and newborns are best preserved by embalming through one of the blood-vessels of the umbilical cord. This is done with the aid of the same apparatus and 10 per cent formalin as described above. All that is necessary is to cut the cord an inch from its attachment to the abdomen and to insert the cannula into the large vein, or preferably into one of the two arteries. After the fetus begins to swell up and the abdomen is well hardened, the embalmment is stopped and the cord tied to prevent the escape of the fluid.

Medium-sized fetuses—that is, those from 2 to 7 inches in length—can be simply dropped into an ample amount of 10 per cent formalin, where they will fix very readily. Care should be taken that the container is not too small, otherwise the soft body of the fetus may become distorted and flattened. For the first three or four days of preservation it is best never to place too many specimens in one jar, but after they are well fixed and hardened there is not so much danger of distortion.

Embryos and fetuses less than 2 inches in length require for excellent fixation somewhat more treatment than larger specimens. In the field the least complicated and most satisfactory method consists of the use of picro-form-acetic, or so-called Bouin's fluid, for initial fixation and alcohol for subsequent preservation. Bouin's fluid consists of the

following chemicals: Picric acid (saturated solution) 75 parts, 40 per cent formaldehyde 20 parts, and glacial acetic acid 5 parts. This can be made up at home, since it will keep for at least six months. If one expects to stay in the field longer, it is safer to take the different ingredients along. The usual 40 per cent formalin is taken anyway and the picric acid, which is explosive in the dry powdered form, can be transported with safety by pouring water into the bottle over the powder. This at the same time will furnish always a supply of ready saturated solution. After the embryo has been fixed in Bouin's fluid for about one to eight days, according to size, it should be transferred to 60 per cent alcohol, where it should remain for only one or two days. After this the preserving fluid can be strengthened to 70 per cent alcohol, in which the embryo can be kept for as long as six months. It is preferable, however, to change again after one or two months to 80 per cent alcohol, which is the best concentration for permanent storage of embryos.

For opening the uterus in order to remove an embryo or fetus, it is better to use a pair of medium-sized scissors with blunt ends, and to start the cutting at the cervix. Great care has to be exercised not to injure the embryo while opening the uterus, and sometimes it may be found advisable to slit the uterine wall only partly and preserve the uterus with the embryo untouched inside. This is particularly necessary in case of very young embryos of small mammals, such as shrews or bats, where a binocular microscope is needed to remove the embryo properly; this can only be done in a laboratory.

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THE MAMMALS OF MAMMOTH, MONO COUNTY, CALIFORNIA

By A. Brazier Howell

In a state noted for its topographic and faunal diversity, few places can be found that are more diverse than certain localities situated upon the eastern flank of the Sierras, and among such, I have encountered none more interesting than the vicinity of Mammoth, California. The charm and interest of the region have caused me to pay it three visits, each of them far shorter than I could wish.

The section covered by the present paper includes the country readily accessible by automobile and by foot. It begins in Long Valley in southern Mono County, where the Owens River winds at 6800 feet through many square miles of irrigated pasture land and contiguous sweep of gentle sage-covered slopes; thence up a nine-mile sage valley bordered by rocky ridges of scattered piñons (*Pinus monophylla*) and junipers (*Juniperus occidentalis*). At 7500 feet begin the pines—western yellow (*Pinus ponderosa*) and Jeffrey (*Pinus jeffreyi*)—which extend north and south over the dry, gravelly slopes of the lower hills in a belt of varying width. Four hundred feet higher is situated the store and post-office of Mammoth, and there is found the first patch of Canadian Zone—a grove of slender lodgepole pines (*Pinus contorta*), these giving way to a thicket of aspens (*Populus tremuloides*) bordering the somewhat marshy margins of the stream. Higher still there are dense, moist woods of aspens, lodgepoles, and firs, the whole flanked by far-flung hills of impenetrable manzanita, chinquapin, and other brush. Forty or fifty years ago parts of the virgin forest were logged off and there was much cord-wood cut for the stamp mill. In its place have grown sage and seedling trees of various sorts, but such patches interrupt zonal continuity to a large degree and local problems are correspondingly complicated.

At 8000 feet begins a sharp rise, on the milder hillsides of which are white firs (*Abies concolor*), the colder slopes being occupied by almost pure stands of the beautiful red firs (*Abies magnifica*). This whole slope is largely morainal in character, and at its top, at 8500 feet, is situated Pine City, at one time a famous mining camp of five thousand souls, but now well nigh obliterated after forty years of desertion. Above this extends a basin some two miles long by a mile wide, wherein are situated the half dozen Mammoth Lakes. These average about 8800 feet in altitude and between them is much timber, chiefly lodge-

poles growing upon gravelly soil. The zone of the lakes is almost entirely Hudsonian. To the west rise steep slopes, forest-covered, granite slides and cliffs rearing sharply above them and culminating in Mammoth Crest at 11,000 feet, with its great snow banks, miniature glaciers, and myriad lakelets. Upon north slopes, windswept and bleak, black hemlocks (*Tsuga mertensiana*) and white-barked pines (*Pinus albicaulis*) appear at 8700 feet, taking on a tortured aspect at a slightly greater elevation and then quickly disappearing; but where insolation is greater, timberline may occur at something more than 10,000 feet. Mountain alders (*Alnus tenuifolia*) and willow (*Salix*) brush are to be found at almost any elevation. The higher country is essentially glacial, huge moraines choking the larger valleys and occurring, along Convict Creek, as low as 7200 feet.

There are no records regarding the annual rainfall of this district. During the warmer months thunder showers are frequent, especially higher in the mountains, but they are so very local that aggregate precipitation is scant. Snowfall is usually very heavy, there sometimes being more than a dozen feet upon the ground at one time at and above Mammoth store, and, hence, it is practically impossible for heavy mammals, such as deer, to spend the winter here. As Long Valley is approached, however, the snowfall decreases, and it is relatively light in the mountainous country to the east. Winter temperatures are said to be quite severe, and although summer days are warm, frosts are frequent during every month of the year, even in the Transition Zone.

As previously mentioned, this region is very diverse in topography, but its chief interest lies in the evident fact that it receives appreciable infusions of the mammalian faunas that are characteristic of the central Sierras, the southern Sierras, the Great Basin, and the "Inyo Region." Especially interesting in this connection is the list of true chipmunks submitted; and, indeed, the number of sciuromorphs in general is quite remarkable. I venture to say that such a condition of affairs would be hard to duplicate in any other region.

With my family I spent from July 11 to August 17, 1914, and from July 5 to August 25, 1917, collecting vertebrates in this locality, and from July 8 to 14, 1922, I visited it in company with J. Grinnell. Unfortunately, the skulls to the 1914 collection were destroyed, and the skins were then dispersed. The results of my collecting in 1917 are now incorporated with the collection of D. R. Dickey, and I am much indebted to him not only for permission to record such of these speci-

mens as are of unusual interest, but also three species of chipmunks secured for him in this region by L. M. Huey during 1916, none of which I obtained. Finally, to Doctor Grinnell my hearty thanks are tendered for help, both on the trip and in assembling the notes for this paper, and for permission to incorporate in it the results of his field work.

Scapanus latimanus monoensis. The mole of the region probably belongs to this race, but it is rather rare and although an occasional working was encountered on a hillside among scattered timber, or at the border of a grassy flat, none was secured.

Sorex vagrans amœnus. During my first two visits no shrews of this form were taken. The reason for this evidently is that they are not found in the area above about 8000 feet, not because of the altitude, but for the reason that, locally, a suitable habitat does not occur much above such elevation. They are animals of the wide, boggy meadows, and in 1922 I found them common in the extensive runways of *Microtus m. yosemite* at 6800 feet upon the floor of Long Valley. They doubtless follow up the open valleys to a short distance above Mammoth Store, recently fixed as the type locality (Howell, Journ. Mamm., 1923, p. 266).

Sorex obscurus obscurus. This shrew is common above 7900 feet and is found chiefly in moist surroundings, such as boggy hillsides dotted with alder and willow scrub, but it also may occur in the drier parts of grassy meadows. It was ascertained that this species (and I have found that some others will do the same) readily eats rolled oats. The mouths of a number were found stuffed with this, some of them having been caught in such a manner that they were killed instantaneously by the springing of the trap. It may have been chance, but I have thought that *obscurus* is less prone to attack and eat specimens of small mammals found in the trap line than are the majority of species of this genus.

Sorex tenellus lyelli. The only individual of this shrew secured, and the fifth specimen known, is a female which I trapped August 16, 1917, among the scrub alders of a boggy spot at 8100 feet. It was identified by Dr. H. H. T. Jackson and is now in the collection of D. R. Dickey.

Neosorex palustris navigator. Water shrews are not very plentiful in this locality and I have trapped only nine. Most of them were secured upon the borders of swift little boreal streams, and in such a situation I surprised an individual one day. It dived and swam under a bank so quickly that I had opportunity to be sure of nothing except that while swimming it kicked both hind feet in unison after the manner of a frog.

Myotis longicrus interior. Bats were common only near our camp at 7900 feet during 1917, but the spot was so located along the creek that it was very hard to shoot them and harder to retrieve those shot because of high marsh grass and swift water. Not more than half a dozen all told were seen elsewhere. The three species obtained could be distinguished on the wing without much difficulty, and the present form was second in point of abundance, two specimens being preserved. Just out of curiosity and with faint hope of success I rigged up an experimental "bat trap." Taking a trout line, I secured to it four very fine leaders of silkworm-gut each about two feet long and several feet apart. To each of these I attached a single artificial "dry fly" of smallest size, and sus-

pended the whole above the stream at a height of about 15 feet, between two trees, at a point much frequented by bats. The flies tossed about in the breeze and I spent the dusk of three evenings manipulating the outfit in various ways, but not a bat paid it the slightest attention.

Myotis lucifugus altipetens. Least common of the three bats recorded, and but two specimens were secured. This form could be told from *M. l. interior* on the wing, and occasionally at early dusk, when bats were fluttering about my head and apparently trying to peer down the gun barrel in the exasperating way common to so many species, while I hurriedly aimed at every point of the compass, the silvery membranes could be plainly distinguished. As far as my experience goes, this grayness of the membranes is diagnostic of the race, but is not nearly so apparent in the dried skin.

Eptesicus fuscus fuscus. By far the commonest bat present, more than outnumbering the other two forms put together. As is usual with this species in the far west, it appeared at a rather early hour.

Ursus americanus subsp. Bear sign is occasionally seen in the country on the east slope of Mammoth Pass, but I met with no indications of the animal.

Canis latrans lestes. Coyotes are rather common in certain parts of the region, especially so among the dry, pine-covered ridges towards the upper edge of the Transition Zone a mile or two south of Mammoth. Their sign in the higher country is more rarely encountered.

Vulpes necator. Red foxes are even rarer upon the east slope of the Sierras than they are to the westward of the high passes, but local trappers occasionally take them in the country above Mammoth. I judge that these are of the above species.

Martes caurina sierræ. There are few places where martens are common in these days, but they are to be found in fair numbers in this region. The trappers get them, and I caught a pair—August 7 and 9, 1914—in steel traps set at rat nests in the middle of an extensive rock slide.

Gulo luscus luteus. A wolverene was killed above Mammoth Lakes a number of years ago, according to local report.

Mustela arizonensis. Weasels are perhaps commoner here than I have known them to be elsewhere in the far west. They are to be found in mountain beaver burrows, perhaps using these as highways, but probably also in hope of finding young beavers; they frequent rock slides for rats and other small game; and they are habitual visitors to ground squirrel burrows. The best way to secure them seems to be by selecting a number of these burrows handily situated for visiting from camp and setting a small steel trap at the entrance to each. After all the squirrels that habitually use these burrows have been caught, one will begin getting weasels, and a number of the nine which I trapped were so obtained. Baiting such traps hardly seems to help, so I judge that the weasels are in the habit of exploring every likely-looking excavation that they encounter.

Mustela vison energumenos. Minks are said to be rare here, and I secured only one—a suckling female on July 20, 1914; another was seen by a friend along the upper creek.

Taxidea taxus neglecta. Evidence of badgers having dug out Belding squirrels was most abundant, and such must constitute the main item of fare. Sign is most frequently encountered in the Transition Zone, but one day I met one of

the animals at 8600 feet, well into Canadian. I judge that he was as hopefully investigating a nearby beaver colony as was I, for, as I drew near, the sounds of my approach drowned in the rush of a mountain stream, I saw, in time to halt, the agitation of the brush a few steps ahead of me which announced his appearance not four feet away. For the space of seconds he was petrified with horrified astonishment, but was then galvanized into headlong panic down the brushy hillside.

Felis oregonensis californica. Mountain lions are occasionally reported in the district. While I was making a lone camp some twenty miles north of here in 1908 my horse was stampeded during the night by a lion, which subsequent investigation showed had circled camp a few yards away.

Peromyscus maniculatus sonoriensis. Deer mice are fairly common on brushy hillsides and in the drier, open woods, but the region evidently is not especially suited to their needs. Not abundant anywhere, and they are practically absent from the patches of heavy, moist-bottom timber—an association occupied by *Evotomys* farther north, but in which, south of the range of the genus, *Peromyscus* often replaces it.

Neotoma cinerea cinerea. About Mammoth I have never caught pack rats farther than a few yards away from the rock slides, but in this association they are abundant and easily secured. Their homes are often indicated by a very few sticks of rather small size, or, if deeper among the rocks, by the excrement lodged in pockets of the boulders, in addition to the characteristic odor of the animals. Parts of the floor of the old stamp mill at Pine City are covered with feces, and several families live among the intricacies of the wooden ore chutes. All members of the genus, so far as I know, are omnivorous, but the bushy-tails are far more herbivorous than are their smooth-tailed relatives. When distended with food their intestines contain an astonishing amount and in all cases noted this has been of a bright green color as if composed solely of succulent plants. I have speculated much but rather fruitlessly in regard to the winter food of the species. They are undoubtedly storers of provisions but I doubt whether they range far afield, and the more numerous chipmunks and gilded squirrels probably leave few seeds for them in the rather barren vicinity of the rock slides. On the other hand, one would imagine that they are not partial to a winter diet of hay alone.

Microtus montanus yosemite. During 1914 about fifteen of each of the two species of vole were caught, but 1917 was a year of scarcity for this form and but one was secured, although the other meadow mouse was as common, if not more so, than before. During 1922, however, trapping was done also in the great meadows of Long Valley, at 6800 feet, and this is undoubtedly the real home of this form in the region—in Transition—although occasional individuals have been taken as high as Pine City. This proved to be a year of great abundance and the little fellows were fairly swarming. As an index to their numbers, I may mention that on July 10 I set some 50 traps at 4 p.m, and after fishing for an hour and a half, found that I had caught 22 voles and a dozen or more small toads. On the following morning these same traps held 28 voles, 2 *Sorex*, and 8 toads—52 mammals and some 20 toads in fifty traps within fifteen hours. In all, 170 were trapped within a week or so along a half mile of stream bank. The population here was surely close to the saturation point, for it is hard to con-

ceive how these animals could have been more abundant. However, the crowding was local, for in other spots a couple of miles away where conditions seemed nearly or quite as favorable, there was but little sign. The most populous area was along a swift creek through the extensive, swampy pastures of Long Valley. Here the water is led so as perpetually to irrigate the grassland, on which the growth is exceedingly lush. The animals do not frequent this where the ground is very level for the burrows would then become flooded, but rather are they found along the creek banks. Here, due to the sharper slope, are patches always moist but never too wet, with small rills over low spots seeking the creek every few yards. Although their runways cross tongues of such ground, this form will not live where the soil is dry enough to support a vigorous growth of the local *Iris*, even if there is also a good supply of green grass. One reason for this, I think, is that they desire burrows in tough, peaty soil that is damp and consequently cool. The burrows are very numerous and extensive, intersecting to such an extent that it was found impracticable to make a study of their meanderings through the tough, fibrous soil. Surface runways are present in the greatest profusion and perfection, being as well defined as I have ever seen them. Not only through the taller grasses were they carried, but across smaller areas where cropping by cattle had been close, every protruding blade having been cut and the runways themselves well rounded at the bottoms. These sometimes cross puddles of water of several feet expanse, or flowing rills a few inches wide, but seldom where there is much current. That they do not object to a wetting is certain, but yet I gained a distinct impression that they are averse to continual dabbling about in the wet. During a rain it was impossible to catch them in any but well-sheltered runways, and they were certainly most active for a couple of hours before darkness and again for an hour or so well after sun-up, probably on account of the copious dew at this spot. There seemed to be comparatively little activity during the middle of the day or middle of the night, judging by the condition of the specimens caught. At any rate, their pelage is not adapted to continued wetting and is easily water-logged.

This is the summer habitat, and nesting is carried on below ground. During the winter, globular nests of grasses four to seven inches in diameter are constructed on the ground beneath the snow, on or against a tussock or clod, and there was much evidence that they had recently occupied a "niggerhead" formation—probably during the winter. These niggerheads, or tussocks of a certain grass, are some ten inches or more in diameter and are separated by spaces a few inches wide by as much as a foot in depth. The clumps were honey-combed by burrows and there were many surface nests as well, but all were practically deserted at the time of our visit. The tussocks doubtless furnish relatively dry retreats free from the danger of being flooded during the winter, while between them there is the requisite amount of moisture. Along the runways, shared by *Sorex v. amœnus* and hordes of yearling toads, the voles were often seen darting at great speed. Food must consist of but few items, for this constant irrigation encourages the growth of but three or four species of grasses and a sedge.

Microtus mordax sierræ. I have always found the meadow mice of this group to be more adaptable to a variety of conditions than is *M. montanus*, or indeed, the great majority of voles. They seem never to be highly gregarious nor to construct well-defined runway systems, and their numbers do not fluctuate from

year to year to any conspicuous extent as is so often the case with many other members of the genus. At Mammoth I have caught numbers here and there as I would *Zapus*, as low as 7800 feet among the grass and flags of a moderately dry pasture, or just as often among the succulence of the Hudsonian growth bordering a precipitous stream from the great snow banks, and I trapped one even in the middle of a large rock slide. But seldom can one define runways; rather must one look for the feces, for these, when the covering is thick and rank, will usually be deposited in little piles upon the occasional small stones and bits of wood—possibly resting stations to which items of food may be brought for leisurely consumption.

Lagurus curtatus. The sole claim of this genus to a place on the present list rests on old but unmistakable sign among the *Artemisia tridentata* of Long Valley just to the east of the Owens River, made probably during the previous winter by a single individual or pair. The species has been taken 20 miles away near Owens Lake. The portion of Long Valley to the west of the river is probably too moist, or rather, the drier parts are too much interrupted by swift streams and little meadows for the tolerance of this genus.

Thomomys fuscus fisheri. This pocket gopher is common along the drier edges of the moist meadows of the lower country around 6800 feet and extends up, even in the sage brush, as high as 7900 feet. At the latter elevation, however, it never progresses for even a little way into the moist meadows. This form is more prone to travel or forage upon the surface of the ground than are the majority of gophers, for I have caught three of them in mouse traps in the vicinity of which there were no visible holes, and but one specimen of any other species in such a situation.

Thomomys monticola monticola. Rather common here and there from 8000 feet, or the lower edge of Canadian, to the upper edge of the Hudsonian Zone. At its lower limit it occupies the cool, moist patches of meadow within, or at the edge of, the timber, and in such situations I have taken it and *fisheri* within a few yards of each other, but each occupying its own distinct habitat. Summer *monticola* caught in cold, wet meadows are always very ragged and never seem really to assume the summer pelage, or rather, this is not completed, and those caught in such situations usually present the most dilapidated appearance. At a greater altitude they are quite partial to the drier, grassy meadows and well-drained gravelly slopes among the open timber, and in such surroundings the summer coat is normally completed. I have also found workings on the borders of lakelets as high as 9800 feet where, in August, there was much snow and conditions were so alpine in character that the stunted willows were only just starting into leaf. In winter, well-drained situations are sought and the remains of cold-weather activities, in the form of the characteristic earthen cores pushed through snow tunnels above ground, are much in evidence. In fact, this winter sign so far exceeds any indication of summer activity that one is forced to wonder at the discrepancy. The only possible explanation that occurs to me is that there is estivation during parts of the warmer months, or else, the burrows having been greatly extended during the winter, further work is unnecessary in summer because the rapidly growing root-ends push into the tunnels as fast as needed, obviating the necessity for more digging. However that may be, it is a proven fact that certain races of gophers often remain in a wakeful state for considerable

periods of time without there being any noticeable extension to the burrow systems.

Perognathus parvus olivaceus. These pocket mice are abundant residents of the drier flats covered with *Artemisia* from the floor of Long Valley, at 6700 feet, to 7800 feet. They, with *Eutamias m. pictus* and an occasional *Peromyscus*, constitute the small-rodent population of the sage flats.

Zapus pacificus alleni. Jumping mice vary considerably in numbers from year to year. During 1914 but one was secured, while 23 were trapped over the same ground in 1917, and comparatively few were found in 1922. They occur in reasonably dry meadows or along the boreal banks of little rushing streams from the high snow banks. In fact, their habitat practically duplicates that of *Microtus m. sierræ* throughout the region except for the fact that *Zapus* occurs along the bank of the main stream at 6900 feet, which is some 900 feet lower than I took the vole.

Erethizon epixanthum epixanthum. Sign of porcupines in the way of scars well up on the trunks of youngish conifers—mostly red firs—is often to be seen and I have found the remains of two of the animals but no live ones. In 1914 I observed where one of these animals had long since had its abode in the hollowed base of a large tree, in which there must have been a bushel of the characteristic excrement.

Aplodontia rufa californica. Mountain beavers are abundant wherever there is a suitable habitat from 8100 to 9200 feet. In seeking the animals one must search for a springy hillside or ravine with a good growth of mountain alders and willows, besides boreal plants. The ground must always be moist, with sufficient seepage so that some of the burrows are saturated; but, on the other hand, there must be enough slope and consequent drainage to prevent marshiness. In the country immediately above Mammoth I know nine colonies varying in size from the workings of a single animal or family to complicated labyrinths that are evidently communal. I am well aware that several writers have affirmed that not more than a pair of mountain beavers occurs in one burrow system, and this may well be so in the northwest where the country is almost everywhere suitable for burrows. However, in the district under consideration, spots thoroughly suited to the needs of this genus are of limited extent, and I am convinced that they are often, if not usually, occupied by an optimum number of individuals. At any rate, I have caught several adults in the same trap within a week in a large, segregated system of burrows following a ravine, with workings extending for three or four yards on either hand and a hundred yards continuously along the banks of the stream. From this I secured seventeen individuals of all sizes in 1914, and then ceased trapping while there were some of the animals yet remaining, as shown by fresh excavations. In 1917, eleven beavers, four of which were adult females, were caught here, and in 1922 the colony seemed prosperous, although no traps were set. After a couple of the animals are caught the remainder become more wary and increased care is necessary in setting traps. I have seen less indication of food-storing by the beavers in this locality than in the states farther north. In fact, all I have observed of such activity here have been a few wisps of succulent plants at the entrances to the burrows as though these had been dropped by accident. They certainly do not go in systematically for the drying, or rather wilting, of plants, as I have observed *A. r.*

rufa doing in Oregon. They are doubtless active beneath the snow all winter and the main source of provender at that season is probably the alders and willows, bent prostrate against the ground by the weight of the snow. In support of this contention I have found burrows yet remaining in contiguous snow banks in July, and the bark of very slender brush well browsed three or more feet above the roots.

The burrow systems of *Aplodontia* are much used as covered highways by many of the small mammals of the region. In them I have trapped *Sorex o. obscurus, Zapus, Microtus m. sierræ, Sciurus*, marmots, weasels, and a mink, and within a colony I once surprised a badger, as previously noted. The rodents are undoubtedly merely seeking sanctuary, but the carnivores are probably guilty of sinister intentions towards the kit beavers.

Marmota flaviventris sierræ. Woodchucks are abundant throughout the region wherever there are rock slides, and these occur from 8000 to 9500 feet or more. From July 12 to 15, 1917, I trapped in a mountain beaver burrow six small young that were barely able to get about. I have also caught adults in such situations, when the burrows were particularly large, and I judge that the marmots use these, when convenient, during their journeys to water. The drier, abandoned portions of the burrow systems may also be used to some extent as homes by these animals. Marmots are sometimes referred to as "mountain beavers" by summer campers from parts of Nevada.

Citellus beecheyi fisheri. These ground squirrels are rather sparingly distributed over the region where there are rocky outcrops or rough ground among the rather scanty brush of the Transition Zone below 6700 feet.

Citellus mollis stephensi. I trapped a nearly grown immature male (now No. 32,939, Mus. Vert. Zoöl.) near the Owens River at 6800 feet on July 13, 1922. Their burrows were present in small numbers within the margin of a belt of huge *Artemisia* six feet high that bordered the alkali flat to the east of the river. Among the short grass of this flat, not more than ten or fifteen yards away, burrows of *Citellus beldingi* were abundant. Doctor Grinnell shot several of the latter animals. Thus, these two species occupy immediately contiguous associations, probably more or less harmoniously and without either encroaching upon the domain of the other.

Citellus beldingi. This "picket-pin" occupies grasslands or the adjoining parts of sage slopes so situated that the burrows are not apt to be flooded. Personally, I have not here observed it above 9000 feet, but it goes considerably higher in other parts of its range. In the great pastures of Long Valley, and indeed, wherever food is plentiful, it fairly swarms, not only in some one favorable year but every season I have encountered it. This squirrel, in common with other species of similar build, always seems to me to be singularly inefficient, but its numbers contradict this impression. At any rate, it is a poor and clumsy runner, and being often surprised far from its home, should prove an easy prey to carnivores. Badgers dig them out in numbers, and as the best way to catch weasels seems to be in traps set at squirrel burrows, these blood-thirsty terrors probably account for a great many. Subsidiary burrows, or refuges, of small extent are maintained in various directions from the main den. The species is omnivorous. It relished available mammal bodies that were discarded; but the main item of its fare is grass, and it will graze along over the short sward left

by the cattle like some small ungulate. At the time of our visit in 1922 there were present vast numbers of a strikingly-marked cicada (*Okariagana magnifica* Davis) which, emerging throughout the sage flats, congregated in the willows along the creeks emptying into Long Valley. The *Citellus*, in common with chipmunks and doubtless most of the other mammals, were feeding extensively upon these insects. Searching through the grass until an individual was encountered, the squirrel would seize it and at once eat out the soft parts, the thorax and wings then being discarded. An investigation—rather superficial—was made in the single field of very luxuriant alfalfa in Long Valley for possible depredations. The squirrels living upon its borders are legion, but the damage was very slight and seemed to be limited to the tenderest growth. In fact, it can hardly enter into their menu to a greater extent than as a relish. The adults become excessively fat towards fall. Doctor Grinnell observed that the females with young were prone to occupy the meadowy land along the creeks, while the old males were out in the drier sage-brush territory adjoining; but this is not invariably the case by any means.

Eutamias minimus pictus. This chipmunk is confined to the sage where, in 1917, it was very common indeed; but during 1922 there were decidedly few observed. It is an adept at concealment and may be overlooked where common unless sought for by trapping during the day.

Eutamias alpinus. This little fellow was noted on several occasions but is of rather rare occurrence throughout the region. None was taken by us, but L. M. Huey obtained three for D. R. Dickey just to the westward of Mammoth Crest during 1916. They are confined to rocky slopes with sparse vegetation, always above 9000 feet.

Eutamias panamintinus. A single individual of this species was secured at Casa Diablo Hot Springs, elevation 7200 feet, August 28, 1916, by L. M. Huey collecting for D. R. Dickey. It is a chipmunk of the dry piñon and juniper covered hills, and this is the farthest north it has been recorded along the main Sierra Nevada; they are probably rare in the locality.

Eutamias amœnus monoensis. This is the common brush chipmunk of the region; not that it is confined to the undergrowth, for timber is abundant, though not dense, in its habitat, and it is always ready to whisk up to a lower limb for observation. However, it is but seldom found away from ample ground-cover and rocky ledges, or some such unevenness into which a home can be built. It occurs as low as there is any timber or heavy brush, and I have taken it as high as 9300 feet; but its center of abundance is in the Canadian Zone. Here it is very industrious, and where there is an especially fine crop of chinquapins or other favorite harvest, dozens of the little fellows will congregate; but they are alert at the first sign of an intruder and take to cover while yet there is ample time.

Eutamias speciosus frater. This form occurs regularly in small numbers from 7900 at least to 9000 feet, but its habits are extremely secretive and unless a sharp watch is maintained, it will be lost sight of among the far more numerous *monoensis*. The half dozen which I secured here were all among lodgepole pines, usually where the trees are large and not too close together. They are very much given to slipping quietly to a tree as one approaches and ascending upon the opposite side. Frequently, no amount of subsequent search will reveal the animal in the tree top.

Eutamias speciosus inyoensis. Hunting during July of 1922 at an elevation of 9800 feet, which is the very upper edge of the Hudsonian Zone at this point, while a bitter wind blew through the white-barked pines near timberline, I shot a chipmunk and saw a second which were different from all others obtained. This, Mr. A. H. Howell pronounces to be entirely typical of the present form, and not tending towards *frater*. It is the northernmost station for the race and indicates an interesting state of affairs, for *frater* is here interposed between this Sierran range of *inyoensis* and its main habitat on the White Mountains to the eastward. This seems also to be the southernmost record station, upon the east slope, for *frater*, and hence the two forms, considered races of the same species, are here interdigitated, each distinct and segregated at its chosen elevation.

Eutamias townsendii senex. One lone chipmunk that was larger than anything taken in the region was seen running along a dead log in the lower Canadian Zone; and Mr. Huey obtained one for D. R. Dickey during 1916.

Callospermophilus chrysodeirus chrysodeirus. Gilded squirrels are found all through Transition here wherever there is suitable cover, and as high at least as 9200 feet. They are exceedingly shy throughout the section under consideration, as they so often are, and chiefly seen while they are wildly dashing for cover well out of range. When a shot is obtained, it is usually at an individual perched upon a stump under which is the home burrow, and unless paralyzed instantly, the animal will almost invariably kick and twitch beyond reach.

Sciurus douglasii albolimbatus. Chickarees are not rare here, and are more terrestrial in habits than are those I have encountered elsewhere. When surprised upon the ground they practically always seek to escape by running instead of climbing. They are to be found from the lowest woods at 7900 feet to just below timberline, and I suspect them of living largely in burrows and in rock slides. In an unbaited steel trap set at a hole in a mound of earth in the woods, I caught three full grown males from July 23 to 26, 1917.

Ochotona schisticeps muiri. I shot only a single coney during each of my first two visits to the region. This may have been, and probably was, because I was handicapped in hunting them on account of being unable to hear them. Be that as it may, Doctor Grinnell found the animals quite common during 1922, ranging from 8000 feet to an undetermined elevation. At 9400 feet on July 20, in a rather small slide that was well segregated by a great snow bank on one side and a boreal flower garden on the other, I shot from her favorite rock a female containing three rather large embryos, and two days later, a half grown young from the same perch. This slide was too circumscribed to support more than a single family, so it appears that two litters of young are produced each year, at least in some cases.

Lepus townsendii townsendii. White-tailed jack rabbits occur from the sage of Long Valley to above timberline, to which abundant feces and the reports of local residents bear witness. Doctor Grinnell and I each saw one of the big fellows in the low country during 1922, but higher up they usually spend the day under stunted hemlocks or other low growth from which they are not easily startled.

Lepus californicus deserticola. Black-tailed jacks are abundant throughout the lower sage stretches—much more so than are their larger relatives. The

giant *Artemisia* bordering the Owens River flats have their tops greatly pruned and altered by the nibbling of the rabbits which are able to reach them when most other local vegetation is beneath the snow.

Odocoileus hemionus hemionus. Deer are abundant in the Canadian and Hudsonian zones during the summer. The does favor the denser woods, feeding on the herbage along the streams and in open glades during late afternoon and early morning, but the bucks seem to remain in the higher country below timberline where they feed in the meadows about the little alpine lakes during the hours of darkness. In winter they are unable to cope with the deep snows usual in the locality and, late in the fall, are reported to leave entirely and travel to the more arid hills and low mountains to the east of Long Valley, where there is much less snow.

Ovis canadensis sierræ. There are a few sheep left in the rougher country below timberline and I saw a limited amount of sign on one occasion during 1914. Upon the approach of winter they travel to the southward, some of them crossing the ridges to the mountainous country towards the southeast, while others doubtless spend the cold weather on the more open slopes of the Sierras above Owens Valley—or so say the old timers.

NOTE.—I strongly suspect that snowshoe rabbits are present, as a friend reported having seen a small rabbit among the aspens near Convict Lake. There should also be flying squirrels, and very possibly fishers, although it is possible that the latter do not cross the high ridges onto the eastern slope of the mountains.

Pasadena, California.

THE RED SQUIRREL

By William Everett Cram

Have you noticed, in October, little mushrooms hanging in the twigs of the pine trees? For years I had given them only a passing glance, taking it for granted that birds or squirrels had left them there, the remnants perhaps of an interrupted meal.

I cannot recall now just what it was that first led me to give them a more careful inspection, which disclosed a number of interesting things; namely, that all these little mushrooms were of one particular kind, that very few of them had been bitten into, and that they were nearly always in groups or collections, several dozen perhaps, suspended in the lower branches of a few neighboring trees.

I soon found that this was the work of the red squirrels, who gather them one by one, run up the pine stems with them and out along the slender dead branches, and then very carefully place each one in a forked twig. Some are only a few feet from the ground, while others are high in the tree tops. After drying for a few days, or a week perhaps, according to the weather, they are added to the squirrels' winter hoard of nuts and acorns, not all in one place, however, but some in knot holes and hollow branches, and some in the nests of twigs and leaves in the pine tops, and still others in holes beneath logs and stumps. While he is busy about this matter of storing away his dried mushrooms, the red squirrel frequently stops long enough to make a luncheon of one or more of them, and he also eats some of the fresh ones when they are first gathered, but the leaving of the others among the branches, is certainly not a mere matter of chance. It is just as deliberate and foresighted an action as is that of the farmer when he spreads his hay or corn to dry in the sun and gathers it under cover before the next rain.

I have seen a few of the red squirrel's mushrooms hanging exposed in the rain, but only a few. On the whole I think he gets caught in this way less frequently than does the average farmer.

Whether this practice of drying mushrooms is merely local, or is common to all the red squirrels inhabiting the wooded portions of the northern United States and southern Canada, I do not know, but I have never seen it referred to in any nature writing, nor have any of the naturalists or more casual observers to whom I have mentioned the subject, apparently observed it.

It is probably a habit dating back through the untold ages, for all the wild creatures are exceedingly conservative. If, like the human

FIG. 1

race, they are ever subject to periods like our present one, when all are anxious to discard old ways and experiment with new, there is certainly no record of anything of the sort.

It may be that other squirrels have this habit, but I have never seen any evidence that they do, and, as far as I can find out, the red squirrel is the only one who ever does more than gather stores of ripe nuts and acorns and seeds and grain for the winter.

It is the red squirrel who has learned that by cutting off the pine cones in late summer, and burying them under the pine needles, they will ripen and retain their seeds to serve him for food in the winter, months after all the other cones have opened wide their scales and scattered their seeds to the winds. And the most amazing thing of all

FIG. 2

is the way he will start out on a winter morning over deep, new fallen, trackless snow, and dig right down to the exact spot, where months before he had cached a dozen pine cones.

When the spring thaw has wasted away all but the hard packed bottom layer of the snow drifts, you may trace his little snow tunnels straight away from the first pile of cones uncovered to the next, and from there on to another several rods away.

It is out of the question to suppose that the sense of smell can lead him here. He must have a most wonderful knowledge of location, in addition to that keen sense of direction, common in varying degree to

all wood folk. His energy in all weathers is pretty nearly inexhaustible, and is apparently the only thing that keeps him warm as he scurries over the drifts and up the maintop of the timber pine in the wintry blast. He has neither thick fur nor any layer of fat beneath his skin to keep him warm, yet, though his well stocked granary would perfectly well enable him to live in sheltered comfort from fall till spring, he never misses a day out of doors, be the weather what it may. His diet is more varied than that of any other animal that I know of, except perhaps the raccoon and the bear, including, as it does, meat, fish, insects, corn, fruit and mushrooms. And I think that he is the only one who packs his winter fruit so carefully that it is by no means uncommon to see him emerge from his hole late in the winter with a ripe, unfrozen apple to be eaten in comfort on the sunny side of the evergreens.

He gets his meat in winter by gleaning after the larger and more successful hunters of the forest, for, although fond of giving chase to small birds of any sort at any season of the year, he appears to be generally unsuccessful as a hunter. In the summer he robs birds' nests, high or low.

He has a standing grudge against the larger gray squirrel, whom he evidently looks upon as a trespasser, whenever the latter ventures to gather nuts or acorns in or beneath the tree which he, the red squirrel, considers his own private property. And you may often see the red chasing the gray round and round and up and down the trunk of hickory or butternut or beech in the fall of the year. Yet, if as sometimes happens, the gray squirrel is cornered at the end of a limb, out of leaping distance from any other tree, the red squirrel contents himself with backing away to a safe distance and taking it out in scolding. I have never seen or had reported to me an instance of their actually coming to blows; a few spiteful nips at the gray squirrels' bushy tail being the closest encounter that I have ever witnessed.

In an old volume of natural history, which I used to read over and over as a boy, the red squirrel is characterized as a shrewd, lively, dexterous, industrious Yankee squirrel, and I have never yet found a better discription of his personality.

While occasionally mischievous and in some slight degree destructive, I believe that his service as a forester far outweighs the little harm he does.

It was in Thoreau's writings that I first had my attention called to the red squirrel's work of replanting the hard woods.

Of course other squirrels, as well as wild mice and blue jays, have their part in the work, and other writers in ages past have taken note of it, but coming to me as it did, I shall always associate the planting of the nut trees with the red squirrels. The wild cherry, the hackberry and the thorn apple, and all the other trees with seeds embedded in an edible pulp, depend upon the birds for spreading them abroad, and the evergreens, birches, elms and maples, with winged seeds, depend upon the winds; but the nuts and acorns are nearly all carried away by the squirrels, and a certain proportion of them are carefully planted each season at just the right depth to insure germination.

FIG. 3

It is undoubtedly the squirrel's intention to return later and dig them up, either to be eaten or else carried to another hiding place, after the hurry of the harvest season is over, but many a squirrel is killed in the meantime, while others migrate to other woods, leaving their buried nuts and acorns to sprout into oak and beach and hickory seedlings in the spring.

Very likely those that are left forgotten in hollow logs and cavities high up in dead trees, may lie hidden in the dry and rotten wood for years, until the tree falls and the wood decays, and rain and melting snow awaken the dormant germ within to new life.

Hampton Falls, New Hampshire.

NOTES ON EPTESICUS FUSCUS

By A. Brooker Klugh

[*Plate 5*]

Early in January, 1923, a male big brown bat, *Eptesicus fuscus*, was presented to me by Mr. G. S. Coward, who had caught it in his cellar. I had this specimen under observation from that time until the first week in March, and as information on bats is somewhat scanty it seems desirable to give a brief account of the behavior of this individual.

Disposition. At first this bat was very savage, uttering its sharp, "chirring" note when touched and attempting to bite when handled. In four days, during which time it was handled frequently and given food and drink, it became much more tractable, and in a week it was quite tame, never trying to bite, nor squeaking, unless suddenly seized. It would lie in my hand quite contentedly and when I stroked its head it went fast asleep. At first when liberated it would always alight as far from me as possible but later it was as likely, and seemingly more likely, to alight near me than elsewhere.

Food. At first it refused everything offered it, though unfortunately I could find no insects to offer, but after a few days it took cooked tongue which had been moistened with water. Later it ate veal and beef, uncooked and cooked, veal jelly, ham, and cooked haddock, but refused bread or anything of a vegetable nature. It ate only very small pieces of any of these foods, and had great difficulty in handling pieces more than two millimetres in diameter. It used its long, flexible tongue with considerable dexterity in getting material into its mouth.

Drink. Eptesicus was always ready for a drink of water, and usually would not eat until it had had a drink. The water was given to it in a small shallow dish, and it had two methods of drinking. The method most frequently employed was to run its lower jaw under the water, scoop up a little, and suck it down with a biting movement, as if it were "eating" the water. The other method, which was not often used, was to lap it up as a dog does. Bats seem to drink while skimming over the surface of a body of water, and this "scooping up" method is probably used at such times.

Sleep. It spent nearly all its time in sleep, hanging on a rod I fixed in its box, or hanging from the edge of the box by its hind feet. Usually it woke about seven o'clock in the evening, and if let out then

1

2

3

4

BIG BROWN BAT (EPTESICUS FUSCUS)

1.—Alighting. 2.—After alighting. 3.—Asleep. 4.—On a stump. Photos by A. Brooker Klugh.

(Klugh: Notes on Eptesicus fuscus)

would fly about for some time. When going to sleep it hung itself up and commenced to shiver; its respirations, which during activity were about a hundred per minute, became slower and slower; its body relaxed, the tremors ceased and it was fast asleep—all in a period of two minutes. Its sleep was extremely deep—more of a hibernation than an ordinary sleep—and its respirations seemed to occur about once in five minutes and often were so slight as to be undetectable. Even in its deepest sleep auditory stimuli caused a response, a very slight noise being reacted to by a jerk of the head and body.

CLEANING. It cleaned itself by licking and scratching. The alar membrane and the interfemoral membrane came in for a good deal of the washing, during the course of which the former was stretched into all sorts of shapes. The back and sides were scratched with the hind feet, one of these at a time being run from behind forward with a rapid scratching motion.

ALIGHTING. In alighting it caught with the thumb-hooks while the wings were expanded, took hold with the feet, folded the wings, and turned head downwards.

THE GUIDING SENSE. That the guiding sense of bats on the wing is not sight but a superfine sense of touch—a sense which detects the presence of an object by the rebound of air without actually touching the object—seems to be definitely proven by the experiments of Spallanzani and Schöbl and the histological investigations of the latter. Nevertheless I thought it worth while to experiment for myself, and I found that Eptesicus was able to avoid objects, and even to dodge objects thrust suddenly in its path of flight, with its eyes sealed up with adhesive plaster as well as with the eyes uncovered.

Queen's University, Kingston, Ontario.

THE BASIC IMPORTANCE OF LIFE HISTORY STUDIES

By Walter P. Taylor

Among all fields of inquiry open to the ambitious student of the higher vertebrates there is none, perhaps, which gives promise of greater returns in significant information than that of their life habits and relations to their surroundings. The rapid rise of so-called ecology to a place of well-merited prominence and importance is one of the most outstanding and encouraging developments of present-day biology. The basic character of researches in this field needs no demonstration, but a brief summary of some of the most conspicuous points may be helpful.

LIFE HISTORIES, STRUCTURE, AND CLASSIFICATION

The classification of the present is based almost wholly on form and physical peculiarities; but variation extends notably to habits and mental traits as well as to structural features. A habit of mind or behavior may be as definite, as characteristic a part of an animal's makeup as a longer or shorter tail or body. Differences in habits and aptitudes are no less significant, though sometimes less usable in classification, than differences in form of skull or brain. It is unnecessary to settle the question as to whether the habit preceded the structure or the structure the habit. The important thing is to recognize the close connection between them, and to appreciate the fact that there is no possibility of a full understanding of structural characteristics without an insight into the habits of the species and its relations to its environment. It seems obvious that an adequate classification must take account not only of the structure of the animal but also of its life history and relation to its surroundings.

LIFE HISTORIES AND PALEONTOLOGY

The probable life histories as well as a considerable proportion of the probable habitats of animals of past ages must of necessity be worked out from a study of the structure of such of their remains as have been found. This reconstruction of the life histories and habitats of fossils is dependent, of course, upon a knowledge of the relations between the habits, habitats, and structures of living species. But those in closest touch with present day studies of, for example, mammalian life histories best realize how inadequate is available information even for species which are abundant and widespread. The painting of a more accurate

and complete picture of conditions during geologic time depends upon the increase of present day knowledge of life habits and ecology.

LIFE HISTORIES AND DISTRIBUTION

The intimate relation between life history studies and distributional problems also is becoming increasingly obvious. The determination of the factors controlling distribution is inevitably dependent on a knowledge of the relations of the species concerned to climate and the other features of its surroundings. Apparently we must know far more about the habits and ecology of animals than we do now, if we are to give satisfactory answers to questions under this head. It is clear that historical factors, involving centers of origin and possibility and direction of coming in to a given region, and environmental factors, such as food, shelter, and relations to other organisms, must be disposed of before we can deal in any convincing way with climatic factors. Until studies of life histories are far more complete than they are at present it will be impossible, except, perhaps, in a few instances, to determine which ones of the distributional factors are of critical importance in any given case; and it looks as though a considerable part of the discussion of the relative importance of temperature and humidity in distribution is for the most part premature, so far, at least, as many of the higher vertebrates are concerned.

RELATION OF LIFE HISTORIES AND ECONOMIC PROBLEMS

It may fairly be stated as a general proposition that the improvement of agriculture, including forestry, horticulture, and animal husbandry depends on a better understanding of the relations between plants and animals and their surroundings. On the animal side this means study of the habits and ecology of all species which now are or may become of economic importance, whether harmful or beneficial.

Life history studies must be relied upon, first of all, to determine whether a species is harmful or beneficial. In economic matters we often proceed as opportunists as a matter of dire necessity. In some cases it is not to be doubted that adequate information regarding the life history of a particular species would show present policies in conservation or control to be mistaken. We are probably not as yet in position to decide as to the absolute status, whether harmful or beneficial, of several species in relation to which the solution of the problem is important. The matter is somewhat complicated by the fact that the status of the same species may vary under different conditions and in different parts of its range.

After determining the economic status of the various species, reliance must be placed on certain important information regarding their habits for the proper protection of the valuable kinds and the control or elimination of those which are harmful. There is little doubt that lack of such critical information has caused considerable losses in funds and labor expended in crude and unscientific methods of conservation and control.

In many cases the protection of beneficial species of game works some hardship on the farmer; and the killing of harmful species may remove important checks on the increase of other pests, as in the case of coyotes and prairie dogs. The possible consequences of wholesale campaigns for protection or extermination can be adequately estimated only on the basis of careful studies of the habits and ecology of the forms involved.

The necessity for thorough life history studies is also apparent in attempts at acclimatization and domestication. No one is more eager for light regarding the ecology of the forms with which he works than the fur farmer or other pioneer in domestication. The more he knows of the habits and relations to environment of his animals the more likely he is to become a successful breeder and keeper.

In economic matters, as in distributional and other problems, it is not necessarily knowledge of life histories in general which is of so much importance; perhaps information regarding one or two critical matters will point the way to the quick solution of a given difficulty. But there is no way to anticipate which of these will be critical, so investigations of life histories should embrace every practicable phase of the animal's activities and its relations to its environment.

EDUCATIONAL VALUE OF HABIT STUDY

Few subjects of study possess more absorbing interest than a living animal that can be seen in action. Both children and adults are naturally interested in tracks and tracking; in tracing the relationships of animals to each other and to plants; in observing the migration and movements of animals, their eating and drinking; in finding and examining their dens, nests, and shelters; and in watching their growth and development. Life history studies of the higher animals, at least, deal with materials already a part of the experience of many persons, and so make possible a strong educational appeal; they also furnish the student with information likely to be directly useful to him in the business of living; and pursued in a deep and thorough way, they furnish cultural values as significant as those in any study.

STUDIES IN LABORATORY AND FIELD

The two main avenues of approach to the solution of life history problems are the laboratory and the field. We shall not soon have too much information from either, and both should be followed as far as possible. Not all forms, however, can be studied in the laboratory; and some of the problems are of such character that they can be solved by field investigations only. It seems probable that with the higher vertebrates, at least, more progress is to be expected from studies of animals in nature through the measurement of their uncontrolled activities in relation to surrounding conditions, than from studies under the controlled conditions of the laboratory. There is great need for ready and satisfactory methods of observing and recording the results of the many natural experiments going on all about us, the subjects of our attention being, the while, unaware that the studies are proceeding, or, at least, somewhat at ease in their normal habitats. The preponderance, in the higher vertebrates, of the mental life, apparently sets very definite limits to the possibility of laboratory treatment for the determination of the factors limiting distribution or the facts regarding normal animal behavior. It is believed that there are few persons of wide experience in the observation of animals who would not sympathize with Hornaday's plea for determining the mind of the wild animal along its own natural lines rather than "along the lines of the professor."[1]

METHODS

There is little doubt that the impression, still widely prevalent, that life history studies are unscientific of themselves and of small value as compared with the supposedly more technical taxonomy, morphology, and physiology, gained currency partly as a result of the lack of satisfactory methods. Ecological studies have been for the most part qualitative rather than quantitative, and often, unfortunately, amateurish, disconnected, and inconsistent. The development of an adequate technique, replacing qualitative methods with quantitative, and making practicable a thoroughgoing attack on life history problems in field and laboratory is perhaps the greatest task confronting the present-day student. A large part of the time and energy of the vertebrate ecologist, at the present time, may well be spent in the working out of methods. It is difficult enough to make plant ecology quantitative. How much

[1] The Minds and Manners of Wild Animals, 1922, p. 12.

more difficult it is with higher vertebrates, most of which are capable of movement, many active only at night, and some living hidden beneath the surface of the ground or in trees or bushes. These things, and above all, the highly organized nervous system, which all of them possess, introduce a host of puzzling obstacles which will only be overcome through the application of much time and labor.

SUMMARY

Studies of the habits and relations to their surroundings of the higher vertebrates are fundamental to a proper understanding of their structure and classification. Such studies provide the paleontologist with additional materials for painting the picture of the past; they are prerequisite to a determination of the factors controlling distribution; and they are of immediate practical importance to the solution of problems of acclimatization and domestication. The improvement of agriculture, including horticulture, forestry, and animal husbandry depends on a better understanding of the relations between plants and animals and their surroundings. On the animal side this means study of the habits and ecology of all species which are now or may become of economic importance, whether harmful or beneficial. We must rely upon life history studies to determine whether a given species is harmful or beneficial; and then to help in the effective protection of the beneficial species and control of the harmful. The educational value of life history studies is large, for they make a vital appeal to all normal persons, besides furnishing a quantity of practically useful information. Given serious and thorough attention they possess cultural values second to none. Investigations of life histories must be carried forward both in the laboratory and in the field; it seems probable, however, that with the higher vertebrates, at least, more progress may be expected from the accurate observation and measurement of the activities of animals in their natural habitats than from controlled laboratory experimentation. Of first importance is the development of adequate and practically usable methods, covering studies both in field and laboratory, whereby qualitative measurements will be replaced, so far as possible, by quantitative.

Biological Survey, Tucson, Arizona.

THE PANNICULUS CARNOSUS IN CAT AND DOG AND ITS GENETICAL RELATION TO THE PECTORAL MUSCULATURE

By Orthello R. Langworthy

The panniculus carnosus is a thin layer of muscle, found only in mammals lying just beneath the skin and extending as a broad sheet over the thorax, abdomen and proximal portion of the posterior extremities. The superficial facial musculature and Panniculus carnosus are often spoken of as "skin muscles." Only their position makes the name of skin muscle appropriate; they are really derivatives of skeletal musculature and have gained only secondarily connection with the skin. These muscles are accurately mapped out by their characteristic nerve supply, for, in a manner similar to the innervation of the superficial musculature of the head and neck in mammals by the facial nerve, the superficial musculature of the trunk (Panniculus carnosus) is innervated by the anterior thoracic nerve. The facial muscles and the Panniculus carnosus may therefore be considered to be derived phylogenetically from two distinctly separate regions as evidenced by their nerve supply.

It is the pectoral musculature which gives origin to the superficial trunk muscle. The same insertion to the ridge of the greater tubercle of the humerus and coracobrachialis fascia, and particularly the same innervation through branches of the anterior thoracic nerve are the factors which prove the intimate relationship between these muscles so widely differentiated.

The Panniculus carnosus derives its great interest when we attempt to explain two muscular anomalies occasionally found in man. The *Achselbogen* is a narrow muscular band extending from the posterior to the anterior fold of the axilla. The *Sternalis* muscle when present is a very variable muscle lying on the sternum on the fascia covering the pectoralis major.

Langer in 1846 carefully described the fascia of the axilla and gave the name of "Achselbogen" to this curved fascial surface. He noted that sometimes muscle fibers from the origin of the latissimus dorsi did not join the tendon of the muscle but extended out to an insertion on this fascia or even ran across it to disappear under the edge of the great pectoral muscle. Later writers gave Langer's name *Achselbogen* to this muscle variation.

Turner in 1867 reported examples of Sternalis and Achselbogen muscles in man and first considered them to be rudiments of the Panniculus carnosus in lower mammals. In the following year Wilson published more examples and supported Turner's views.

J. B. Perrin (1873) viewed the Achselbogen as an abortive variety of the dorso-epitrochlearis muscle which latter he considered a rest of the dorsal humeral portion of the Panniculus.

Birmingham (1889) gave a summary of the literature bearing on the Achselbogen controversy up to that time. He became convinced after careful dissections that the connection of the Achselbogen to the latissimus was more apparent than real, that the fibers of the Achselbogen cross obliquely those of the latissimus, that they do not spring from the margin of the muscle, and they are not continued into the fibers of the latissimus but end in an aponeurotic band which is attached to the outer surface of the muscle. He considered that if the Achselbogen was formed from two muscles it ought to have a double nerve supply but this was not the case, for Birmingham found the Achselbogen supplied by a branch from the median anterior thoracic nerve. Since he found that the nerve supply of the Achselbogen and Panniculus carnosus were identical he was convinced that the Achselbogen was a primitive rest of the superficial trunk muscle of mammals.

Le Double in 1897 described the Achselbogen in his variations in human muscles. He took the opposite point of view from Birmingham and since he found that muscle bundles extended directly from the latissimus to the Achselbogen he considered the latter was an abnormal latissimus bundle.

A series of studies have been completed in the field of comparative anatomy in an endeavor to trace the phylogenetic origin of the Achselbogen. The first and possibly the most important of these studies is the work of George Ruge (1895) on the monotremes. These animals possess a well developed Panniculus carnosus and Ruge proved its phylogenetic origin from skeletal musculature (pectoral group), by the insertion of the muscle into the humerus along with the pectoral musculature and by its innervation from the anterior thoracic nerve. Ruge found the Panniculus carnosus in partial connection with the facial musculature but demonstrated very clearly that the connection was only a secondary one.

In *Ornithorhynchus* the muscle covers the ventral as well as the dorsal surface of the body and extends down on the posterior limbs. The fibers covering the ventral surface of the body have a free origin and

insertion in the superficial fascia. They arise in the fascia of the neck, overlying the lower portion of the facial musculature. From this point the fibers sweep caudally, the muscles of the two sides meeting in the midline, covering the mammary glands and extending posteriorly as far as the cloaca. The outer fibers cover the proximal portion of the hind limb and are prolonged on to the tail. This deep layer is inserted with the fibers of the pectoral group to the greater tuberosity and to an aponeurosis over the distal half of the humerus. The whole muscle gets its nerve supply by a branch from the eighth cervical and first thoracic nerves.

The Panniculus carnosus of *Echidna* is very similar but more complicated due to the fact that some of the more caudal fibers have split off from the main muscle mass and partially surround the cloaca acting as a sphincter.

Tobler (1902) in his paper on the Panniculus carnosus of mammals gave a description of the superficial trunk muscle in a marsupial (*Macropus bennetti*). The muscle here consists of a free portion and main muscle mass. The free portion covers the upper thorax and lower back arising from the fascia covering the lower border of the pectoralis and from the ventral midline for some distance below, the fibers extending obliquely, laterally and posteriorly to end in the fascia of the back about the level of the thigh. The main muscle extends dorsalwards meeting the fibers from the opposite side in the dorsal midline, the most caudal fibers of the two sides coming to lie almost parallel and ending at the margin of the tail. At the axilla, the broad spreading muscle becomes very narrow; it slides under the edge of the pectoralis and is attached with the abdominal portion of the pectoralis to the humerus and coracobrachialis fascia. The nerve supply is from the anterior thoracic nerve.

Michelsson (1921) studied *Erinaceus europæus*, an example of the Insectivora. The superficial trunk musculature in the hedgehog is very strongly developed enabling the animal to roll up into a ball when molested. It extends widely over the ventral and dorsal surfaces of the body and on to the posterior limb with strong attachments to the prepuce of the penis, around the anus and to the tail. The more cranial fibers are attached with the pectoralis musculature to the humerus. The facial and spinal accessory nerves supply small portions of the muscle which have become secondarily fused to the main muscle mass; but the main portions of the Panniculus carnosus, homologous to the Panniculus carnosus of the other mammals, is innervated by the anterior thoracic nerve.

Very extensive phylogenetic studies have been made by Tobler (1902) in the above named paper, and Ruge (1905) on the Panniculus carnosus in Old World Primates. From the many species studied by Tobler a few may be described, selected to illustrate the regression of the superficial trunk musculature within the group of Primates, from a normally developed Panniculus carnosus as found in lower representatives of the group to "pectoralis quartus," or *Achselbogen* as occasionally found by them in anthropoid apes and man.

Tobler found the Panniculus carnosus most strongly developed in *Cynocephalus hamadryas*. *Cynocephalus babuin* and *Macacus cynomolgus* show a rather extensive development of the Panniculus carnosus as a thin sheet over the lateral surface of the trunk extending dorsally on to the back and ventrally to the inguinal region. The very strong cranial portion reaches almost to the dorsal midline and is inserted together with the abdominal portion of the pectoral musculature. The anterior thoracic nerve innervates the muscle. *Cercopithecus sabæus* shows a decrease in extent of the inguinal portion of the muscle, the cranial portion being almost as strongly developed as in the preceding example.

In *Cercopithecus cephus* the muscle is very much reduced, the cranial and inguinal portions of the muscle being entirely separate. The cranial portion extends no lower than the eleventh rib. A remnant of the caudal portion of the muscle is found as a small group of fibers in the inguinal region.

Among the Anthropoid apes Tobler found in two gorillas remains of the cranial portion of the Panniculus carnosus, the inguinal portion being entirely lost. This muscle, described as *"Pectoralis quartus,"* is very like "Pectoralis quartus" and Achselbogen occasionally found in man.

Ruge (1905, 1910, 1914), Tobler (1902), and other pupils of Ruge have collected and published a large number of examples of Achselbogen and Sternalis muscles in man, which, from a comparative anatomical basis, they interpreted as remnants of the *Panniculus carnosus*. Frey (1921) has given a short review of this field and added a new typical example of an Achselbogen in man.

Ruge (1905) discussed a very important case in man in which a Sternalis muscle was found in close connection with the pars abdominalis of the pectoralis musculature; the pars abdominalis showed connection with a well developed Achselbogen. Ruge interpreted these as primary connections and tried to prove that not only the Achselbogen but also

the Sternalis must be derived from the Panniculus carnosus of mammals. As the preceding description of the condition within the group of Primates shows, there is no doubt that Achselbogen is phylogenetically derived from Panniculus carnosus and therefore originally from the pectoralis group. However, there are strong objections to the interpretation of the Sternalis as a derivative of the *Panniculus carnosus*. One strong objection to this theory of Ruge brought forward by authors

FIG. 1

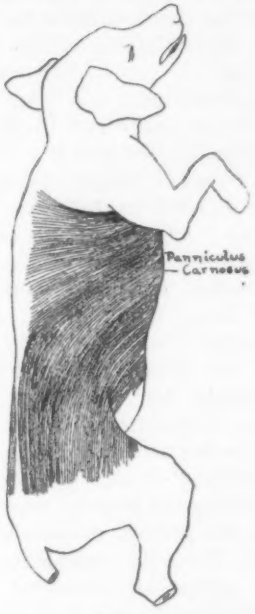

FIG. 2

FIG. 1. LATERAL VIEW OF PANNICULUS CARNOSUS IN THE CAT
FIG. 2. LATERAL VIEW OF PANNICULUS CARNOSUS IN THE DOG

was that no Sternalis muscle was ever found in other Primates. However, in 1910 Van den Broek found a Sternalis in the *Hylobates*. Among the theories differing from Ruge's the most important brought forward to explain the presence of the Sternalis in man was Eisler's (1912). He believed the Sternalis was formed by an incomplete splitting of the pectoral musculature due to failure of development.

PART II

In this paper an endeavor will be made to contribute to the study of the Panniculus carnosus in mammals in general by presenting, with the aid of drawings, the Panniculus carnosus and pectoral group of muscles in two representatives of Carnivora, *cat* and *dog*. The time seems most appropriate for this study since Ernst Huber recently (1918 and 1922) has published a detailed account on the phylogenetical development of facial musculature in these two animals.

The superficial musculature of the cat and dog may be divided into three genetic groups—Facial group (n. facialis), Panniculus carnosus (n. thoracalis ant.), and Pelvic group (n. pudendus). In this study we are concerned only with the Panniculus carnosus and, as comparative anatomical studies show it to be derived from the pectoral musculature, we will consider the pectoral musculature also.

Straus-Durkheim (1845) described the Panniculus carnosus in the cat, dividing it into two distinct portions, a ventral layer which he called the dermogastric muscle and a dorsal mass, the dermohumeral muscle. Birmingham describes a fourth pectoral layer in the cat. Heiderich (1906) found a "Latissimus Achselbogen" beneath a well developed Panniculus carnosus in the cat. Zukerkandl-Tandler (1910) described this same muscle in the dog and in *Ursus thibetanus*. But this "Latissimus Achselbogen" is not homologous with the Achselbogen in man derived from the Panniculus carnosus as Ruge's and Tobler's investigation within the groups of Primates shows very clearly.

Zukerkandl-Tandler also worked out the relation of the Panniculus carnosus to the pectoral musculature in mammals in general. They divide the pectoral musculature into three groups—Pectoralis superficialis, Pectoralis profoundus, and Pectoralis abdominalis. Panniculus carnosus is considered with the latter group. This general classification seems a very logical one and we will follow it in our description of cat and dog.

The *Pectoralis superficialis* of the *cat* (Fig. 3) is not a uniform layer but is divided into several portions showing various differentiation in different specimens. It arises from the upper part of the sternum as far as the upper border of the fourth rib and the main muscle mass is inserted into the crest of the greater tuberosity of the humerus throughout its entire length.

The most superficial portion (Fig. 5 and partly cut, Fig. 3) is a thin, narrow, ribbon-like muscle extending from the upper region of the sternum to the elbow where it is inserted into the antibrachial fascia of the forearm.

The cranial third of the main muscle mass may be divided into a thin superficial and thick deep layer (Fig. 3). The superficial portion is inserted into the lower two-thirds of the crest of the humerus. In specimens where the musculature is well developed the deep portion is sharply differentiated as in Fig. 3. A few of the most caudal fibers of the superficial pectoral layer are not inserted into the pectoral ridge but curving downward to the elbow end in the antibrachial fascia just medial to the insertion of the more superficial portion. The super-

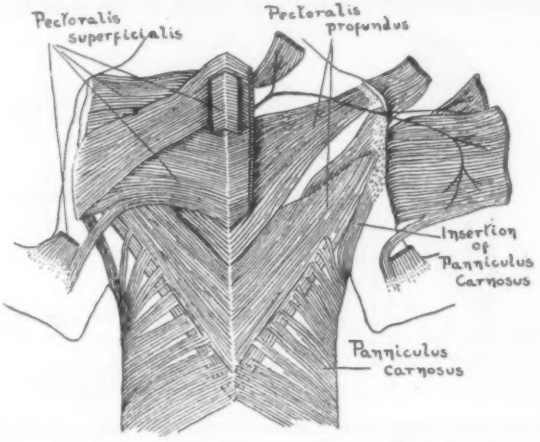

FIG. 3. PECTORAL MUSCULATURE (PECTORALIS SUPERFICIALIS AND PECTORALIS PROFUNDUS) OF THE CAT AND PANNICULUS CARNOSUS IN RELATION TO IT

On right side most superficial portion of pectoralis superficialis indicated cut showing only origin and insertion. On left side pectoralis superficialis cut and reflected to show nerve supply.

ficial pectoral layer in the cat is supplied by the eighth cervical nerve with frequently a few fibers from the first thoracic segment (Fig. 4).

The *Pectoralis profundus* (Fig. 3) is divided into cranial and caudal portions. The cranial portion arises from the sternum within the region from the second to the sixth rib and is inserted into the greater tuberosity of the humerus and capsule of the shoulder joint. The caudal portion arises from the sternum from the sixth rib to the xyphoid process and ends in an aponeurosis which is attached to the middle third of the crest.

The *Pectoralis abdominalis* (Fig. 4) is a narrow thin muscle arising from the xyphoid process and from the linea alba for a short distance. It runs upward beneath the caudal portion of the deep pectoral muscle (Fig. 4) and is inserted between the two portions of the pectoralis profundus. Both the pectoralis profundus and pectoralis abdominalis are supplied by branches from the eighth cervical and first thoracic segments (Fig. 4).

The *fourth pectoral layer* in the cat (Fig. 4) arises from the sternum as an aponeurosis extending from the region of the third to fifth ribs

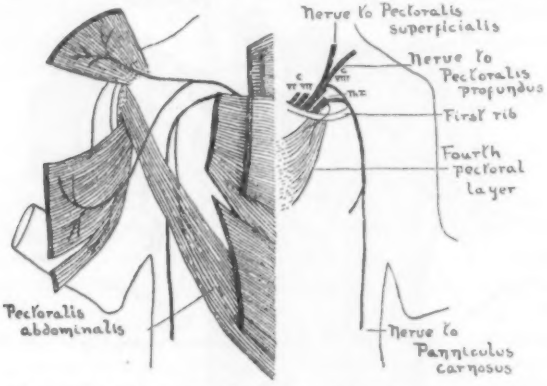

FIG. 4. PECTORALIS ABDOMINALIS, FOURTH PECTORAL LAYER AND NERVE SUPPLY OF THE WHOLE PECTORAL GROUP IN THE CAT

On the right side pectoralis superficialis indicated cut showing only origin. Pectoralis profundus indicated cut and reflected to show nerve supply. Pectoralis abdominalis with nerve supply. On the left side fourth layer of pectoral muscle. Plexus brachialis and branches given off to form the n. thoracalis anterior for the innervation of the pectoral group and Panniculus carnosus.

and turns upward and outward to be inserted into the lower border of the first rib. It is innervated by a small branch from the first thoracic nerve.

The ventral fibers of the PANNICULUS CARNOSUS in the cat (Figs. 1 and 5) arise from the fascia covering the lower border of the pectoralis profundus and from the ventral midline. These extend posteriorly and caudalwards over the inguinal region to be inserted in the fascia over the posterior surface of the thigh. The most posterior fibers of the two sides come to be almost parallel in the dorsal midline and end at the root of the tail (Fig. 1). A few of the caudal fibers in the inguinal

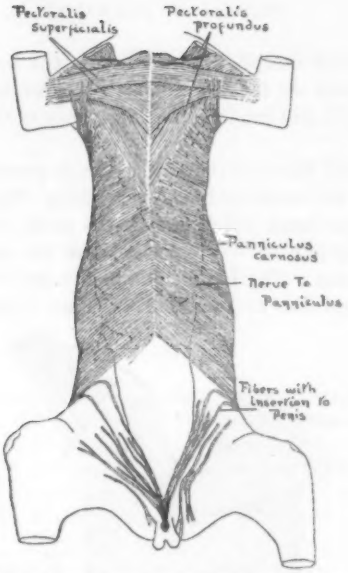

FIG. 5. VENTRAL VIEW OF PANNICULUS CARNOSUS AND PECTORALIS MUSCULATURE IN THE MALE CAT

From the lower border of the Panniculus carnosus fibers bend down to reach the penis. This muscle is innervated by an end branch of the nerve for the Panniculus carnosus (n. thoracalis anterior).

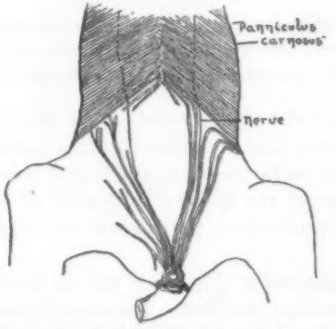

FIG. 6. VENTRAL VIEW OF CAUDAL PORTION DERIVED FROM PANNICULUS CARNOSUS IN RELATION TO THE PERINEAL REGION IN THE FEMALE CAT, SHOWING ITS INNERVATION BY AN END BRANCH OF THE NERVE TO THE PANNICULUS CARNOSUS (*N.* THORACALIS ANTERIOR)

region have become sharply separated from the main portion. They loop downward over the lower abdomen to be inserted into the prepuce in the male (Fig. 5) and beneath the constrictor of the vagina in the female (Fig. 6).

The more cranial fibers of the muscle sweep posteriorly (Fig. 1) and extend nearly to the dorsal midline. Anteriorly (Fig. 3) the fibers form a narrow muscular band which crosses the axilla obliquely and is inserted to the lower part of the crest just below the caudal portion of the pectoralis profundus. The Panniculus in the cat is innervated by the eighth cervical and first thoracic nerves (Figs. 4 and 5).

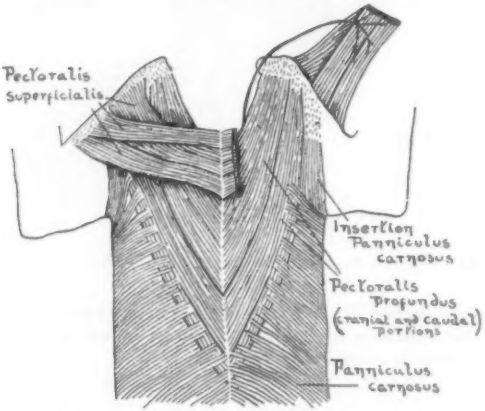

FIG. 7. PECTORALIS MUSCULATURE (PECTORALIS SUPERFICIALIS AND PECTORALIS PROFUNDUS) IN THE DOG AND PANNICULUS CARNOSUS IN RELATION TO IT
On left side pectoralis superficialis is cut and reflected to show its innervation.

In the DOG we find the same general groups of pectoral muscles. The *Pectoralis superficialis* (Fig. 7) arises in three portions from the upper part of the sternum as far as the third rib and is inserted to the whole extent of the crest of the greater tuberosity of the humerus. It is innervated by a branch from the seventh and eighth cervical nerves (Figs. 7 and 8).

The *Pectoralis profundus* (Fig. 7) is not an homogeneous plate but may be divided into two portions. The cranial portion arises from the sternum in the region of the second to sixth ribs and is inserted into the greater tuberosity of the humerus. The caudal portion arises from the sternum from the sixth to the ninth ribs, from the xyphoid process and

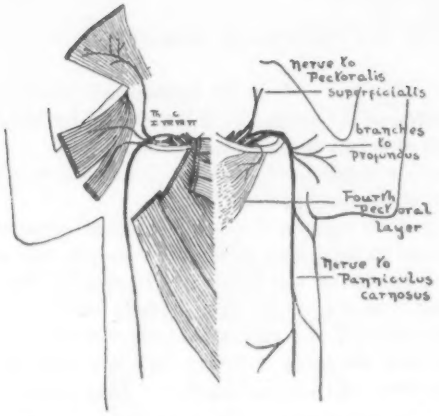

FIG. 8. FOURTH PECTORAL LAYER, PLEXUS BRACHIALIS AND N. THORACALIS ANTERIOR FOR INNERVATION OF WHOLE PECTORAL GROUP AND PANNICULUS CARNOSUS IN THE DOG

On right side pectoralis superficialis indicated cut showing only its origin. (See Fig. 7.) Pectoralis profundus reflected to show its nerve supply. From these branches one long branch is indicated descending to Panniculus carnosus (see left side).

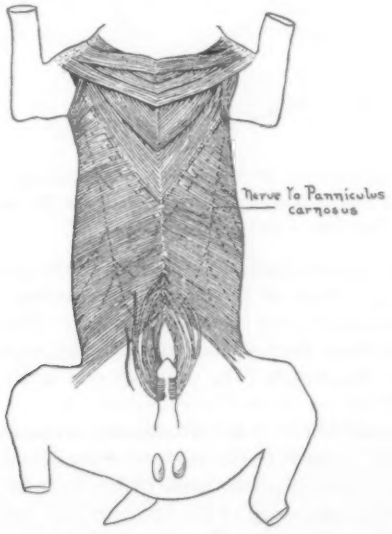

FIG. 9. VENTRAL VIEW OF PANNICULUS CARNOSUS AND PECTORALIS MUSCULATURE IN THE MALE DOG

From the middle line in the lower region of the Panniculus carnosus fibers bend down to reach the penis. This portion is innervated by an end branch of the nerve to the Panniculus carnosus (n. thoracic anterior).

sheath of the rectus and ends in the aponeurosis which is inserted into the upper portion of the crest. It is innervated by branches from the eighth cervical and first thoracic segments (Fig. 8).

The *Pectoralis abdominalis* in the dog is not differentiated from the caudal portion of the deep pectoral layer.

The *fourth pectoral layer* in the dog (Fig. 8) arises as an aponeurosis from the sternum in the region of the third to fifth ribs and is inserted into the lower border of the first rib. It receives its nerve supply through a small branch from the first thoracic nerve.

The ventral fibers of the PANNICULUS CARNOSUS in the dog (Figs. 2 and 9) arise from the fascia covering the lower edge of the pectoralis profundus and from the ventral midline. They extend laterally and

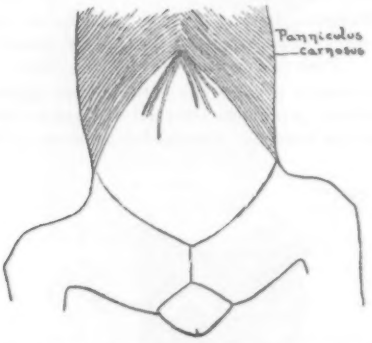

FIG. 10. VENTRAL PORTION OF THE PANNICULUS CARNOSUS IN FEMALE DOG
No portion of Panniculus carnosus is extended into the perineal region as in the female cat. (See Figs. 6 and 9.)

posteriorly to be inserted into the fascia over the posterior surface of the thigh (Fig. 2). Some of the caudal fibers arising from the ventral midline loop downward over the lower abdomen (Figs. 9 and 10). In the male (Fig. 9) these fibers are inserted into the prepuce and corpus of the penis but in the female (Fig. 10) they end in the fascia over the lower abdomen.

The more cranial fibers of the Panniculus carnosus (Figs. 2 and 7) extend posteriorly to insert in the fascia near the dorsal midline (Fig. 2). Anteriorly (Fig. 7) they cross the axilla obliquely to be inserted into the crest of the greater tuberosity of the humerus just below the insertion of the pectoralis profundus. The Panniculus carnosus in the dog as in the cat is innervated by the eighth cervical and first thoracic

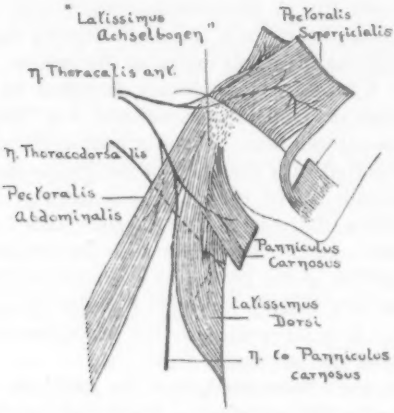

FIG. 11. "LATISSIMUS ACHSELBOGEN" IN THE CAT

Fibers from the anterior border of the latissimus do not join the tendon but cross the axilla to insert between the Panniculus carnosus and pectoralis abdominalis. These fibers constitute the "Latissimus Achselbogen." The n. thoracodorsalis supplies this "Achselbogen."

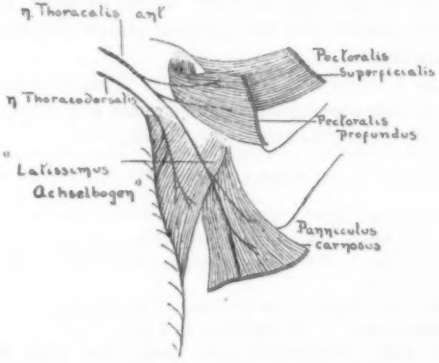

FIG. 12. "LATISSIMUS ACHSELBOGEN" IN THE DOG

The pectoralis superficialis is indicated cut and reflected. The n. thoracalis anterior is shown innervating the pectoralis profundus (cut and reflected) and the Panniculus carnosus. The latissimus dorsi has been turned outward from the chest and is viewed from within. The "Latissimus Achselbogen" is in direct continuation with the main portion of the muscle, not separated as in the cat (Fig. 11). This "Achselbogen" is innervated by the n. thoracodorsalis as is the latissimus.

nerves (Figs. 8 and 9). A physiological experiment confirmed this innervation. Stimulation of the n. thoracalis anterior caused a powerful contraction throughout the whole extent of the muscle.

A "Latissimus Achselbogen" as already described by Heiderich and Zukerkandl-Tandler is found in both cat and dog (Figs. 11 and 12). Fibers forming the anterior border of the latissimus do not join the main tendon but are inserted with the fibers of the Panniculus carnosus and pectoralis abdominalis to the ridge of the humerus. The amount of differentiation of this "Latissimus Achselbogen" varied a great deal in different specimens. In the dog this muscle was in direct continuity with the main portion of the latissimus. In one cat the "Latissimus Achselbogen" was very sharply separated from the main portion of the muscle (Fig. 11). It is innervated by the nerve thoracodorsalis as is the main portion of the latissimus dorsi.

As we see from the above description the pectoralis superficialis is more differentiated in the cat where it is divided into several distinct portions. The pectoralis profundus is very much alike in both cat and dog. The dog in contradistinction to the cat has no separate pectoralis abdominalis. A fourth pectoral layer was found in both cat and dog. Panniculus carnosus has in general the same extent in both animals. However, in the female dog the more caudal fibers of the Panniculus carnosus do not extend into the perineal region but end in the fascia of the lower abdomen.

In conclusion I would like to thank Dr. Ernst Huber, under whose direction this problem was undertaken, for his aid so generously given and for his never failing interest in the work.

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GENERAL NOTES

SPERM WHALES AT ST. GEORGE ISLAND, BERING SEA

Three large sperm whales (*Physeter macrocephalus* Linnæus) were detected playing around the landing near the village of St. George Island, one of the Pribilof Group, in the early morning of May 12, 1923. At one time they came within 50 yards of the rocky shore. The animals were identified and described in the island log entry of that date by Mr. Richard G. Culbertson, acting agent and caretaker; the description given could apply to no other species.

The sperm whale is exceedingly rare in this part of Bering Sea, probably due to the shallow waters. Previous records have recently been published by Edward A. Preble[1] in a paper on the biology of the Pribilof Islands. Publication of this note is made possible through the interest maintained in such matters by Mr. Ward T. Bower, of the U. S. Bureau of Fisheries, who brought the matter to my attention.—G. DALLAS HANNA, *California Academy of Sciences, San Francisco, Calif.*

FISH-EATING DEER

Individuality is as distinct and marked in wild birds and mammals as it is in the genus *Homo*. Given a known set of conditions, one may predict with fair accuracy the action of the average person. The same rule holds with the lesser creatures. But it has sometimes seemed to me that we have been too prone to regard the law of average as the law of all, and so in the study of habits of wild creatures to make the mistake of giving to all of a given species one fixed standard of habits. We have established a rule of conduct, and politely lift the eyebrows in unbelief at the report of any variation from that established line.

Dr. William T. Hornaday, than whom no man has had a greater opportunity for the study of individuality in animals, one time said to me that the older he grew the less inclined he was to say that an animal would or would not do thus or so under a given set of circumstances. Certain experiences of my own have led me to concur fully in the Doctor's opinion.

In no authoritative books on the subject of the habits of deer have I found them mentioned as eaters of fish. Our dainty white-tails are vegetarians. When I have suggested that some of them at least have a liking for fresh fish I have been laughed out of court. I have even been accused of nature faking. Here are the facts.

In June a year ago I was in camp at the mouth of Dole Brook in the Moosehead Lake country in Maine. Owing to the running of logs down the brook with consequent high water, the fishing had been very poor. One morning my wife and I went down to the ledges just below our camp, and as a result of an hour or two of patient casting caught just one trout. This was perhaps ten or twelve inches long. Returning to camp, we hung it on a nail about six feet from the ground in a tree close to the fireplace.

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[1] North American Fauna, No. 46, 1923, p. 116. See also Hanna, Journal Mammalogy, vol. 4, p. 210, November, 1923.

After lunch our party separated, three of us going down the brook and three of us up the brook. My wife and I with our Indian guide were the first to get back to camp. This was about six o'clock. We had a dozen trout. Imagine our surprise when we went to get the one caught in the forenoon to find only the head hanging on the nail. My first thought was that my old friend Billy Mink had discovered the trout, climbed the tree and feasted at our expense.

But Mitchell's sharp eyes had been scanning the ground. "Here are the footprints of your thief," he called, pointing to the ground at the foot of the tree. Imagine my surprise when I discovered the clean cut hoof prints of a buck. The evidence was as clear as if we had been eye witnesses of the whole affair. The buck had stood braced at the foot of the tree and reaching up had bitten off the trout just below the head.

But this was not all. Within less than half an hour while we were busy preparing for supper Mitchell called softly saying, "Here's your thief himself."

Sure enough, there stood a three year old buck, watching with interest our activity. He was not over forty feet away. Mitchell tossed him some bits of corn bread, and he finally came within twenty feet.

Shortly after this the other members of the party arrived, bringing some more trout. These were dressed together with those we had brought in, and the heads and entrails thrown into the brush a short distance from the camp. That buck came in and cleaned them up, thus adding proof to the evidence of his foot prints beneath where the first trout had hung.

One of my companions had had a similar experience. This was at Alligash Lake in Maine. This time it was a doe. She had hung around the camp until she had become fairly tame. One afternoon he came in with a dozen or more small trout in his canoe. He drew the canoe up on the bank and went up to his tent. He came out just in time to see that doe take the last of his catch. Another party had a similar experience at that same lake. Probably it was the same animal.

The question is, how generally are deer eaters of fish? Probably the liking for fish is an acquired taste confined to a few individuals. My own theory in the matter is that these particular animals had hung around camps, picking up scraps of food, and in this way had probably eaten some cooked fish for the sake of the salt. In this way they had acquired a taste for fish for its own sake. Of course this is pure speculation. It seems to me the most logical explanation.

The point of peculiar interest is the demonstration of individuality. These incidents go to prove the utter fallacy of making positive statements as to what an individual animal will or will not do. There was a time when I would unhesitatingly have stated that deer would never eat fish unless possibly in a period of starvation. Now I have three instances of deer eating trout at the season when their natural food was most plentiful.

It is this individuality which makes the study of animal life so fascinating. Let no one think that because he has day by day watched a woodchuck all through the season that he knows all about woodchucks. He may know all about that individual woodchuck, but the woodchuck in the very next field may have characteristics and habits wholly different. This is just as true in the world of birds. Evolution is still going on, and evolution works through the individual rather than through the race as a whole.—THORNTON W. BURGESS, *Springfield, Mass.*

THE GRASSHOPPER MOUSE IN IOWA

An adult female grasshopper mouse with much worn molars was taken by Paul A. Moody, of the Iowa Lakeside Laboratory, August 14, 1923, near West Lake Okoboji, Dickinson County, Iowa. It was taken at the mouth of a small burrow in a gravel pit near the top of a line of hills, just north of the Iowa Lakeside Laboratory. The gravel pit is in a large pasture field largely covered by short grass and the two species of ragweed, *Ambrosia trifidia* and *A. artemisiaefolia*. The specimen is now in the Michigan Museum of Zoology. It is referred to *Onychomys leucogaster breviauritus*, to the description of which subspecies it seems most closely to approximate. So far as I am aware this is the first record of the genus *Onychomys* for the state of Iowa.—L. R. Dice, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

THE REPRODUCTIVE POTENTIAL OF RATS

Many authors have published compilations of figures showing the potential progeny of rats. The number of litters per year has been recorded at from 3 to 12 and the number of young per litter has been stated to vary from 6 to 22, and one instance has been given of a female rat giving birth to 11 young when only eight weeks old.

In 1909 Lantz assumed that rats breed three times per year and the average litter is 10. At this rate and without deaths the increase from one pair is stated to be 432 rats at the end of one year, 93,312 at the end of two years, and 20,155,392 at the end of three years. This is the most conservative estimate we have. Lantz evidently became more liberal with added experience and in 1917 made another estimate, placing the number of litters per year at six but holding to 10 as the average sized litter. By doubling the number of litters he found the progeny of one pair of rats in three years to be about eighteen times as great, or 359,709,482 instead of 20,155,392.

Goldman (in the Quartermaster Review, January-February, 1922) accepts Lantz's estimate of three litters of 10 young per year, as does Rucker ("The Rat in Its Relation to the Public Health," U. S. Public Health Service). Rucker carries these figures to five years and obtains 940,369,969,152 rats. F. Von Fischer in 1872 ("Rats and Mice as Enemies of Mankind," Hinton) carries his figures out for ten years, arriving at the enormous total of 48,319,698,843,030,344,720.

A. C. Hinton, in his "Rats and Mice as Enemies of Mankind," tries to reconcile the breeding propensities of rats with the actual increase. He accepts the basis of calculation used by Zuschlag, of six litters of 8 young in a year, and figures that young rats breed when four months old. He starts with Boelter's estimate of 40,000,000 rats in England and assumes an equal proportion of the sexes. He also assumes that from one cause or another 50 per cent will not have a chance to breed. This reduces his capital stock at the start to 10,000,000 breeding pairs. He further assumes that 95 per cent of these will die by equal monthly installments during the first year, making a total reduction of 97.5 per cent. This waste is repaired by breeding. He figures that 50 per cent of the young die at birth and 50 per cent of the remainder die before reaching a breeding age. The remaining 25 per cent that have a chance to breed are subject to the same mortality as their parents, or 95 per cent in twelve months.

In spite of this tremendous mortality, Hinton finds that his capital stock of 10,000,000 pairs is replaced by 41,000,000 at the end of the year. He also finds that had three litters per year instead of six been used as a basis it would have made comparatively little difference in his figures, as the 10,000,000 original pairs would have increased to 32,000,000.

These calculations would seem to reach the height of conservatism, but that they are far too liberal is indisputable, as they admit a rat population at the end of the year which is more than double what it was at the start. Doubling the number of rats each year would, in ten years' time, result in 1,024 times as many rats as at the beginning.

Some theoretical estimates, while interesting, are entirely misleading, as it is evident that such an increase would end in disaster in a very short time. There is no doubt that Von Fischer could have covered the face of the earth a mile deep with rats by carrying his figures a few years more. Yet it is equally true that there has been no exaggeration in the number of young per litter nor in the number of litters per year. Therefore, as it is evident that if there is any increase in the world's rat population from year to year or from century to century it is very slight, it follows that the normal mortality of rats must be equally as great as the normal reproduction and that any increased reproduction is opposed by increased destructive agencies.

We have numerous records of startling local increases in the numbers of rats under favorable conditions, which prove that the high reproductive potential, when undisturbed, becomes an actuality, but as these are always followed by an equal or greater decrease, the rat population as a whole is maintained at a remarkably constant level.

The high reproductivity of rats is not sufficient in itself, therefore, to allow an indefinite increase in their numbers. It does, however, enable them to recuperate quickly from any unusual depletion in their numbers and is the important factor in the maintenance of rats at their high position in the relative abundance of mammals.—JAMES SILVER, *Biological Survey, Washington, D. C.*

WOODCHUCK IN ALABAMA

Mr. Arthur H. Howell, in his work on the mammals of Alabama (North American Fauna no. 45, pp. 60–61, 1921), defines the status of *Marmota monax monax* in the state thus:

"The woodchuck . . . . occurs plentifully in the rough, hilly country of northern Alabama as far south as Tuscaloosa and Coosa Counties and the Talladega Mountains of Talladega and Clay Counties. Stragglers are sometimes found somewhat farther south. L. S. Golsan states that a single individual—the only one ever known in the vicinity—was killed near Autaugaville a number of years ago (about 1890); and Peter Brannon states that he has seen the woodchuck a few times at Seale."

Of its abundance in the northern counties I can say nothing, for I have yet to see a specimen in life, but I do know that the animal is so rare in central Alabama that when a straggler is seen the natives are at a loss to know what it can be. Such was the case with a fully adult woodchuck that fell before the gun of E. C. Cobern, sixteen miles northwest of Prattville, in Autauga County, about the

middle of June, 1923. For, although many uninformed but accommodating people had ventured sundry tentative identifications, Mr. Cobern's quest for a name for his strange beast remained unsatisfied until one day he happened to show the skin to Mr. Lewis S. Golsan, of Booth, Alabama.

It is worthy of note that this woodchuck was bayed in a briar patch by dogs and that no burrow was to be found anywhere nearby. This would indicate that it was a newcomer in the locality and had not yet established itself. It may be mentioned too that the woodchuck licked the dogs! This positive record, which I publish through the courtesy of Mr. Golsan, will at once indicate the rarity of stragglers and help to fix more definitely the southern limit of the species in Alabama.—Ernest G. Holt, *312 Bell Building, Montgomery, Ala.*

THE BELDING GROUND SQUIRREL IN THE SIERRA NEVADA

The Belding ground squirrel (*Citellus beldingi*) lives in the high meadows of the central Sierra Nevada, and appears to be extending its distribution southward along the crest. Grinnell and Dixon ("Natural Histories of the Ground Squirrels of California," issued by the California State Commission of Horticulture, 1918) give the distribution as starting from the vicinity of Independence Lake, Nevada County, and extending to the southeastern border of the Yosemite National Park in the vicinity of Mount Lyell.

In August, 1922, I inspected the high meadows along the crest of the Sierras south of Mount Lyell and did not find the squirrels in any of those visited west of the North Fork of the San Joaquin River. In the meadows between the North and Middle Forks I found them present in large numbers as far south as the Gargyle Meadows, at 7,955 feet altitude. I found them also along the east slope of the Middle Fork, south along Fish Creek and Mono Creek, over the divide at the heads of Rock Creek, Bishop Creek, Coyote Creek, and at Coyote Flats as low as 6,500 feet. On Coyote Flats the infestation was quite heavy, 115 holes being counted on a quarter of an acre. Their heaviest infestation and damage to the range was in the meadows lying between 7,500 feet and 9,500 feet, and above and below these altitudes they gradually disappeared.

I did not go farther south but some stockmen whom I met at Coyote Flats reported that ground squirrels were in the McMurry Meadows, which are 10 miles beyond. Farther than that point they had not been seen. This is about 50 miles south of the southernmost point reported by Grinnell and Dixon.—F. E. Garlough, *U. S. Biological Survey, Denver, Colo.*

THE HOARY BAT AT MARSHALL, MISSOURI

In the issue of the Journal for August last, Mr. E. Raymond Hall furnished some interesting data (pp. 192–193) on the distribution of *Nycteris cinerea*. Specimens had been taken at Lawrence, Kansas, in June and July, and, among others, a female with two young clinging to her had been collected. Of course this particular specimen indicates that the breeding range of the hoary bat is not confined to Canada and certain northern or mountainous districts of the United States.

Mr. Hall listed no specimens for the month of August, but supposed, very reasonably, that they were present at that time. I have an immature individual

that was taken at Marshall, Missouri, August 17, 1923. This bat was secured when dislodged from an apple tree by small boys. Its measurements—which were taken in the flesh—are quite characteristic for the species: length, 132; forearm, 55; tail, 60. As Mr. Hall suggested, the normal summer or breeding range of *Nycteris cinerea* includes probably a larger territory than has been recognized heretofore.—GORDON ALEXANDER, *Graduate College, Princeton, N. J.*

A CORRECTION

While visiting at Corvallis, Oregon, last summer I had occasion to review a part of my work on the wood rat, and I found that a mistake had been made in the identification of one bird mentioned in the paper published in the Journal of Mammalogy, vol. 4, no. 1, February, 1923. On page 8, line 17, *Salpinctes obsoletus* should read *Thryomanes bewicki calophonus*.—P. F. ENGLISH, *College Station, Texas.*

RECENT LITERATURE

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CORRESPONDENCE

THE SLIDING OTTER

Editor, Journal of Mammalogy:

A discussion has arisen on the subject of the sliding of an otter, and the position in which the legs of the animal are held while sliding. Strangely enough I have had great difficulty in finding eye witnesses of this well known habit of the otter. It occurs to me that there may be some members of this Society or readers of this Journal who can give first hand evidence on the subject. I would like very much to hear from anyone who has seen a sliding otter, describing the position of the legs during the sliding.

Very truly yours,
T. W. Burgess.

61 Washington Road, Springfield, Mass.

HIBERNATING CHIPMUNKS

Editor of the Journal of Mammalogy:

In a late issue of the Journal of Mammalogy, Mr. A. H. Howell makes mention of the fact that there is but little published on the hibernating habits of the chipmunks.

Many years ago I uncovered some two or three *Eutamias townsendii* after they had retired to their winter quarters. I am unable at this time to state the exact date but as I remember it was in the late winter and the location was about eight miles west of Portland, Oregon. The animals had selected a sloping hillside and were deep under large fir stumps. Each nest was a small bunch of shredded vegetable fiber, in the center of which the chipmunk was curled, the tail covering the head and as far along the spine as it might reach. Hibernation was complete, the animal being stiff and cold, the flesh almost as if it might be frozen. There was no food either in the nest or in the earth under the stump, so far as could be discovered by human hands. The entire stump was uprooted before we finished the job. No two chipmunks were found under the same stump, nor, as I recall, near enough to be considered "neighborly," though all were on the same hillside and under similar conditions.

I have not yet forgotten nor forgiven one of the sleepers that I tried to befriend. Thinking to revive it I placed it inside a buckskin glove and laid the glove near the fire. An hour later I discovered that the experiment was a success, so far as bringing the chipmunk to life was considered. It had thawed out and also had eaten out of the glove, leaving a hole in the palm large enough to have passed a small skunk, while it could just as easily have escaped by the hole in the gauntlet and have left me with something to wear.

A. W. Anthony.

San Diego, Calif.

THE J. A. ALLEN MEMORIAL FUND

The members of the American Society of Mammalogists will be glad to hear that the J. A. Allen Memorial Fund, inaugurated in honor of the late Dr. Joel

Asaph Allen to commemorate his long and distinguished service to the science of mammalogy, has met with cordial response from many quarters. It has appealed to those having the interests of the Society at heart as well as to others desirous of encouraging the study of our fast vanishing wild life, including thus the nature lover, sportsman, and scientist. The memorial has proved to be a fitting and gracious tribute to the sterling character and great talent of one of the founders of American mammalogy.

The fund is now over half completed and on a firm basis. It is most desirable that all members not having subscribed yet, should assist in completing it at an early date,[1] so that the interest will become available for the annual publication of more important papers, dedicated to the memory of Joel Asaph Allen, which should have a far reaching effect on the development of mammalogy at home and abroad. It may be of interest to state that this is the only memorial fund ever established to a mammalogist. Papers published from the income of this fund will appear in the *Journal of Mammalogy*, the only periodical in the world devoted solely to this branch of natural history.

The President of the American Museum of Natural History, Prof. Henry Fairfield Osborn, and several members of the Board of Trustees, including Messrs. Cleveland H. Dodge, Childs Frick, and Madison Grant were among the first contributors. Of the other members of the Society the chief contributors were Miss Annie M. Alexander, Messrs. S. Prentiss Baldwin, Thomas Barbour, Courtenay Brandreth, George B. Grinnell, Ernest Thompson Seton, and the Hon. George Shiras, 3rd. Among the non-members, Mr. James B. Ford was most generous in his support.

At present this endowment, the minimum of which is set at $10,000, amounts to over $5,000. The largest contributions from members were two at $500; next came one at $200; one at $125; seven at $100; eleven at $50; twenty-three at $25; five at $20; one at $15; thirty-five at $10; one at $7; thirty-five at $5; and four at less than this amount. From interested friends and admirers of Doctor Allen who are not members of the Society there have been sixty contributions totaling $1,050, which represents approximately one-fourth of the present sum subscribed.

To those who had the privilege of being intimately associated with Doctor Allen and knowing his modest ways, earnest sincerity, and good judgment, it is particularly gratifying to think that he himself would have favored a memorial of such lasting benefit to mammalogists in general. From the letters of contributors it appears they are especially pleased with this manner of keeping Doctor Allen's name alive to posterity and at the same time serving so well the interests of mammalogy.

Herbert Lang.

[1] Checks should be made payable to the J. A. Allen Memorial Fund. They may be addressed care of H. E. Anthony, Secretary and Treasurer, American Museum of Natural History, Central Park West, New York City.

AMERICAN SOCIETY OF MAMMALOGISTS

By-Laws[1]

ARTICLE I. NAME AND OBJECTS

Sec. 1. This society shall be known as the American Society of Mammalogists.

Sec. 2. The object of the Society shall be the promotion of the interests of mammalogy by holding meetings, issuing a serial or other publications, aiding research, and engaging in such other activities as may be deemed expedient.

ARTICLE II. MEMBERSHIP

Sec. 1. The Society shall consist of Members, Honorary Members, and Patrons.

Sec. 2. Any person may become a Member upon recommendation of two Members and election at the next annual stated meeting, or by special election at other times by a two-thirds vote of the Directors (which may be obtained by correspondence). Members are entitled to vote for all officers and to receive the serial publication of the Society.

Sec. 3. Honorary members shall be elected by a majority vote of the Society upon unanimous recommendation of the Directors in recognition of distinguished services to mammalogy. They shall be exempt from all dues and shall be entitled to all privileges of members except that they shall not be eligible to office or to membership on the Board of Directors.

Sec. 4. On payment of one thousand dollars, any person recommended by the Board of Directors may be elected a patron and shall be entitled to all the privileges of a member, shall receive all publications of the Society, and shall be exempt from membership fees.

ARTICLE III. OFFICERS

Sec. 1. The Officers of the Society shall be a President, two Vice Presidents, a Recording Secretary, a Corresponding Secretary, and a Treasurer. These, together with the Editor, the Ex-Presidents, and ten persons elected from the Society at large, shall constitute the Board of Directors of the Society.

Sec. 2. Officers shall be elected annually and shall be eligible for reelection; they shall perform their duties until their successors shall qualify. The Editor shall be appointed by the Directors. Five Directors shall be elected annually from the Society at large and shall serve for two years. Officers shall be elected by a majority vote at the annual meeting, and their official term shall commence at the close of the meeting at which they are elected.

Sec. 3. Vacancies among the Officers or Directors may be filled temporarily by appointment by the Directors, and persons so appointed shall hold office until their successor shall have been elected.

ARTICLE IV. MEETINGS

Sec. 1. An annual stated meeting shall be held in accordance with the action of the Society at the preceding annual meeting. Due notice of such meetings shall be given by the Corresponding Secretary.

[1] As amended at the Fifth Annual Meeting, May 15, 1923.

Sec. 2. A special meeting of the Society may be called at any time by order of the Directors, provided that notice of the purpose and date of the meeting be given at least thirty days in advance.

Sec. 3. Sections of the Society may be organized by five or more members in any locality, with the approval of the Directors of the Society in each case, for the purpose of holding meetings for the presentation of papers or discussion. Sections may have their own officers and rules, but such rules shall not conflict with the By-Laws of the Society. Each section shall present to the Society an annual report of its activities.

ARTICLE V. QUORUM

Twenty shall constitute a quorum of the Society and five a quorum of the Directors.

ARTICLE VI. AMENDMENTS

Amendments to these By-Laws, recommended by the Directors, may be adopted at any annual stated meeting by a two-thirds vote of the members present, provided that notice of each proposed amendment has been sent to each member two months before the meeting.

ARTICLE VII. RULES

Upon recommendation of the Directors, Rules may be adopted, amended, or repealed at any annual stated meeting by a majority vote.

ARTICLE VIII. FEES AND ACCOUNTS

Sec. 1. Annual dues for members shall be three dollars, payable in advance.

Sec. 2. Any member upon payment of seventy-five dollars at one time shall be entitled to life membership, and shall be exempt from membership dues.

Sec. 3. All moneys received from life members and patrons in consideration of their election as such, and all gifts for undesignated purposes, shall be invested as a permanent fund, the income of which may be used for special purposes as directed by a three-fourths vote of the Directors. The accounts of the Treasurer shall be audited, as directed by the President, at the close of each year before presentaton at the annual stated meeting of the Society.

ARTICLE IX. FUNDS AND TRUSTEES

Sec. 1. Bequests and trusts having for their object the advancement of mammalogy or the welfare of the American Society of Mammalogists may be accepted and administered by the Society. Before acceptance of any such trust the Directors shall consider the object of the trust and all conditions or specifications attached thereto, and shall make a report to the Society for its action.

Sec. 2. A board of three trustees elected by the Directors shall hold all the funded property of the Society in trust with power to sell and to reinvest according to their judgment. One trustee shall be elected for a term of three years at

each annual stated meeting. Vacancies among the trustees may be filled by election at any time by a majority vote of the Directors (which may be obtained by correspondence).

Rules

RULE I. ELECTION OF OFFICERS

The election of officers shall be as follows:

Nominations shall be made in each case by an informal ballot, and the result announced by the Secretary, after which the first formal ballot shall be taken.

In balloting for Vice-Presidents and the five additional Directors, each member shall write on one ballot as many names as there are officers to elect, namely two on the first ballot for Vice-Presidents and five on the first ballot for Directors; and on each subsequent ballot as many names as there are officers still to be elected, provided that the number of persons receiving a majority does not exceed the number of persons to be elected, in which case the vacancies shall be filled by the candidates receiving the highest majorities.

If in any case the informal ballot result in giving a majority for one or more of the persons balloted for, it may be declared formal by a majority vote.

RULE II. ORDER OF BUSINESS

The order of business at the annual stated meeting unless changed by a two-thirds vote of members present shall be as follows:

1. Reading and approval of the minutes of the previous meeting.
2. Report of the Recording Secretary.
3. Report of the Corresponding Secretary.
4. Report of the Treasurer and Auditing Committee.
5. Election of members.
6. Election of Officers and Directors.
7. Appointment of temporary committees.
8. Report and recommendations of the Board of Directors.
9. Action on business reported by the Directors.
10. Consideration of amendments.
11. Reports of committees.
12. New and unfinished business.
13. Appointment of permanent committees by the President elect.
14. Reading of the minutes of the meeting.

RULE III. DELINQUENTS

Members whose dues are in arrears for more than one year shall not be entitled to receive the Journal of Mammalogy.

The names of members whose dues are in arrears for more than two years shall be presented to the Directors for action.